Natural Oyster Ground Survey 2011

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Surveys of Delaware's natural oyster grounds have been conducted annually since 1974. Historically, harvest from these beds occurred during a two to four week period in the spring, dependent on the overall availability of oysters for transplanting. Oystermen would harvest "seed" oysters and transplant them onto their leased oyster beds which are located south of the natural oyster beds. These oysters would "fatten" in these higher salinity waters thus improving the overall market quality of the oyster. Generally, these oysters were harvested in the fall of the same year they were planted and sold to shucking houses for processing and eventual distribution to the public. Due to low oyster densities caused by disease, poor recruitment and harvesting losses, the transplant fishery was closed from 1986-1990 and closed permanently in 1996. Legislation enacted in 2001 replaced the transplant fishery with a quota based direct market oyster fishery. The purpose of this survey is to evaluate population trends, collect recruitment data, to determine mortality rates and annual relative changes in overall stock densities. These data are used to monitor and evaluate the dynamics of the oyster resource and provide the input data needed by the Division of Fish and Wildlife to generate annual management measures that are designed to protect and enhance the oyster resource on the natural oyster beds.

Methods

Historically, sampling was conducted using the R/V "Ringgold Brothers", a 65-foot oyster schooner. Dredges were deployed and retrieved from the starboard side of the vessel. Beginning in 2002, the R/V "First State", a 62-foot custom–built research vessel became the primary sampling platform. Sampling protocols were carried over to the new vessel with the following exception; the dredge is deployed and retrieved from the stern on the R/V "First State".

Sampling was conducted in October at 62 sites on ten separate natural oyster beds and the Leipsic River (Figure 1 and 2). Each bed was sampled with a six bushel hard bottom toothed dredge. The dredge is constructed with a 62 ½" tooth bar with 24 teeth measuring 3 ¾" long and spaced 2 ½" apart. The dredge bag is constructed with ¼" rings with a 2 1/8" inside diameter spaced 2 ½" apart. Sampling at each station consisted of a 45 second tow generally with the prevailing tide. A one bushel sample of oysters and cultch material is randomly selected from each dredge load. The remaining dredge material is deposited in bushel containers in order to determine the total volume of the dredge haul. Once the total dredge haul is determined then this material is shoveled over the side back onto the bed. The one bushel sample that was randomly collected is then examined to determine the total number of live oysters, box counts (to estimate mortality) and percent shell in the sample. Live oysters were sorted into three categories; spat ($<$ 2cm in length), smalls (2-7.5cm) and markets ($\geq$ 7.5cm). The number of samples collected from the individual beds varies depending on the overall size of the bed. For example, the Ridge Bed is the largest bed and has fifteen samples while the Drum Bed is much smaller and has three samples taken on this site. Specific counts are recorded from each sample site, and then pooled together for calculating an annual arithmetic mean for the entire bed. The small and market category oysters from each site are set aside until the entire sample has been counted. Of these oysters, 50 are selected at random and are measured to the nearest millimeter for calculating height frequency distributions for each bed.

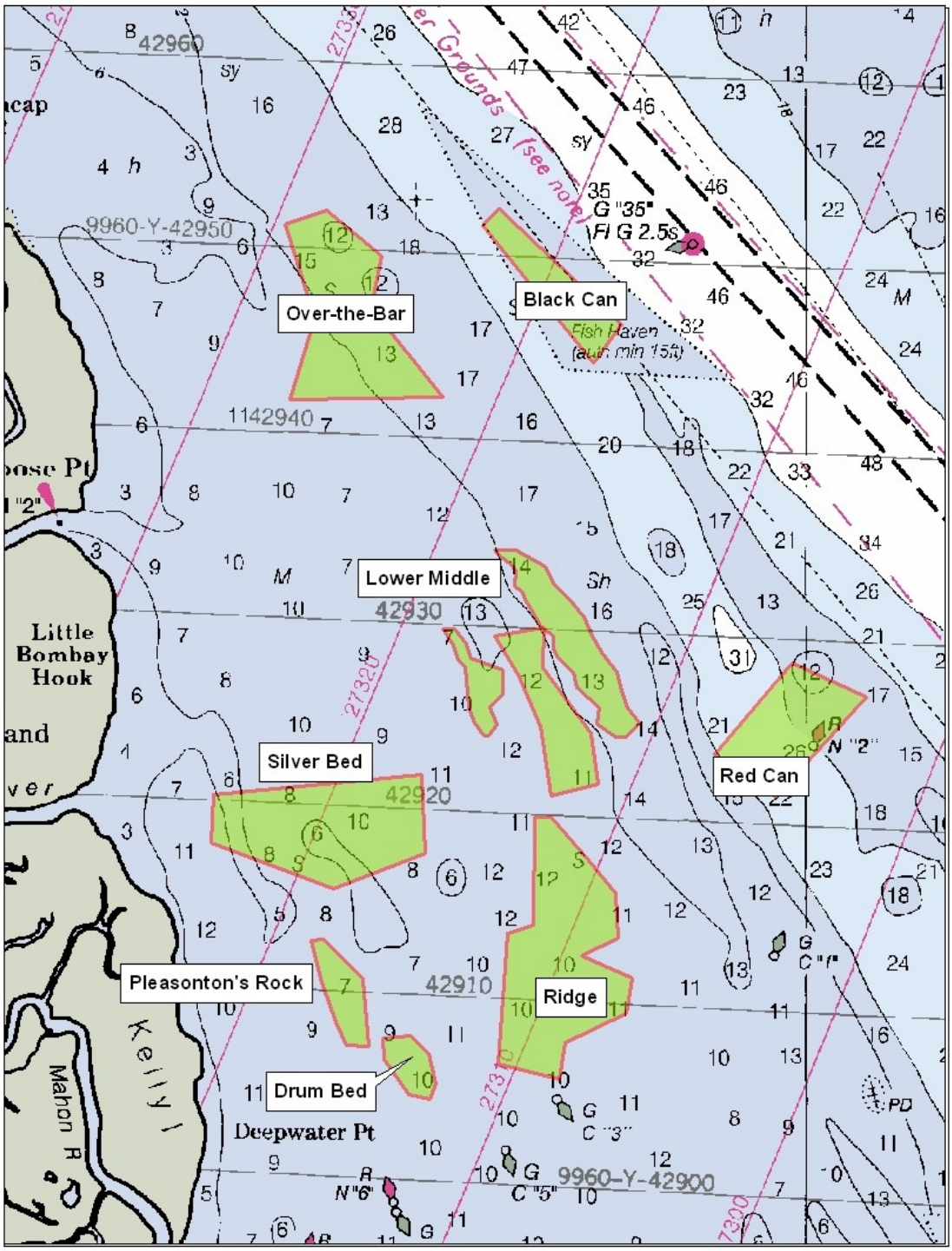

Figure 1. Location of Delaware's natural oyster seed beds in the Delaware Bay.

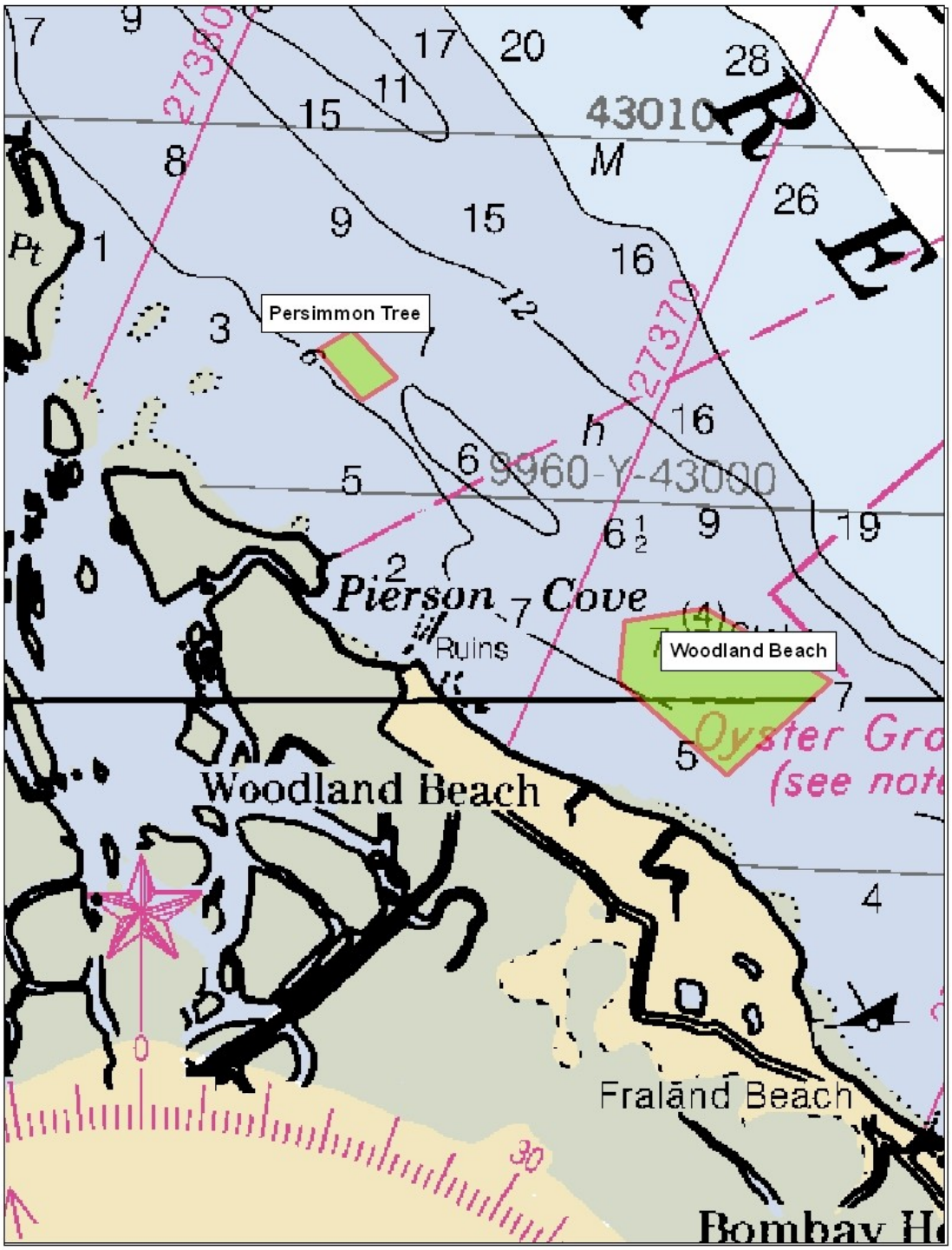

Figure 2. Location of Delaware's natural oyster seed beds in the upper Delaware Bay.

In association with the Delaware Bay Oyster Restoration Task Force, the Division has participated in annual shell plantings on some of the State's natural seed beds. These plantings initiated in 2005, are designed to provide clean cultch material to achieve maximum larval retention of larval oysters and are conducted just prior to peak oyster spawning in August. After a year of no activity, funding was secured to plant approximately 30 acres on a section of the Lower Middle area. The Division also conducted a supplemental shell plant on the Black Can bed as remediation stemming from the Athos oil spill event in 2004. To date, a total of 1,080,602 bushels of cultch material consisting of oyster chaff and clam shell has been planted on the natural seed beds from 2005-2011 (Table 1 and Figure 3).

Table 1. Summary of shell planting activities on Delaware's natural seed beds, 2005-2011.

Year	Location	Area (acres)	Material Planted	Amount Planted (bushels)
2011	Lower Middle	30.0	Clam shell	52,047
	Black Can	26.0	Clam shell	60,029
2009	Silver Bed	38.0	Clam shell	78,681
2008	Lower Middle	33.0	Clam shell	67,562
	Over the Bar (North)	25.0	Clam shell	46,081
	Ridge	26.0	Clam shell	53,296
	Over the Bar (East)	33.0	Clam shell	50,536
2007	Over the Bar	51.0	Clam shell	83,808
	Ridge	51.7	Clam shell	104,163
	Silver Bed	50.0	Clam shell	107,072
	Lower Middle	38.0	Clam shell	75,793
2006	Pleasanton's Rock	40.9	Clam shell	53,986
	Drum Bed	32.9	Clam shell	47,582
	Silver Bed	29.9	Clam shell	81,156
2005	Jigger Hill Bed	19.7	Oyster chaff	54,650
	Lower Middle Bed	22.3	Oyster chaff	46,382
			Clam shell	17,778

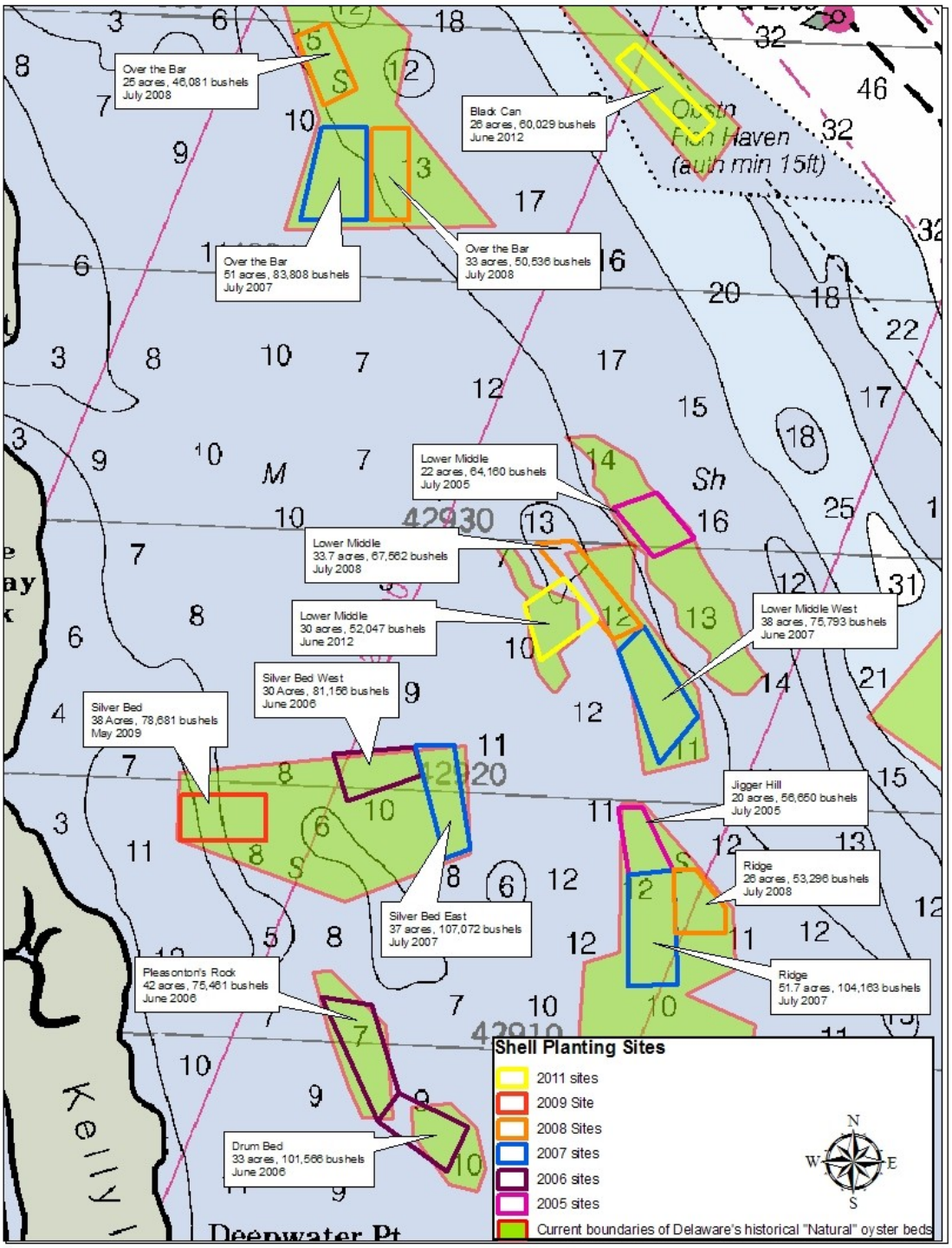

Figure 3. Location of shell plant activities on Delaware's natural seed beds, 2005-2011.

Results

Ridge

Over the first four years (November-December, 2001- 2004) of the direct market fishery, the Ridge accounted for the majority of the oysters harvested: 45% in 2001-2002 (Whitmore and Cole 2003) and 61% during 2003-2004 (Whitmore and Greco 2005). This was not unusual since this particular bed has historically been the most productive seed bed since the survey was started. Based on the findings from the 2004 survey (Figures 4 and 5), the Department decided to close the Ridge to direct harvest due to the extremely low estimate of stock abundance generated from the survey. This area was closed to direct harvest from 2005-2008. Following the 2008 survey it was determined that the density of markets in the 2005 Ridge (Jigger Hill) shell plant site would support commercial harvesting. As such, the Ridge was opened primarily to allow harvesters the opportunity to utilize the oysters that were located in the twenty five acre planting site. Preliminary reports show that 36% of the 2011 harvest came from the Ridge (DDFW 2012).

A total of 15 sites were sampled on this bed, as described in Greco, 2005. The 2011 survey data can be found below in Table 2.

Table 2. Oyster stock density derived from one-bushel samples collected from the Ridge in 2011.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	2	2	0	3	99
2	13	40	101	19	55
3	8	35	106	27	50
4	4	1	0	2	99
5	7	23	50	12	60
6	11	38	73	26	55
7	0	0	1	1	99
8	6	4	3	7	95
9	1	0	4	1	98
10	0	0	0	0	100
11	5	9	2	2	85
12	5	2	0	3	99
13	2	3	2	1	98
14	6	41	125	22	45
15	1	4	4	9	95
Avg.	4.7	13.5	31.4	9.0	82.1

Review of the historical data shows that when the direct market fishery opened in 2001 the number of market oysters per bushel declined each subsequent year due to natural and fishing mortality (Figure 4). The number of markets increased just over 4% in 2011 but remained well below the time series average at 13.5 per bushel. The average number of small oysters per bushel increased (56%) to 31.4/bu., and remained well below the time series average in 2011 (Figure 5).

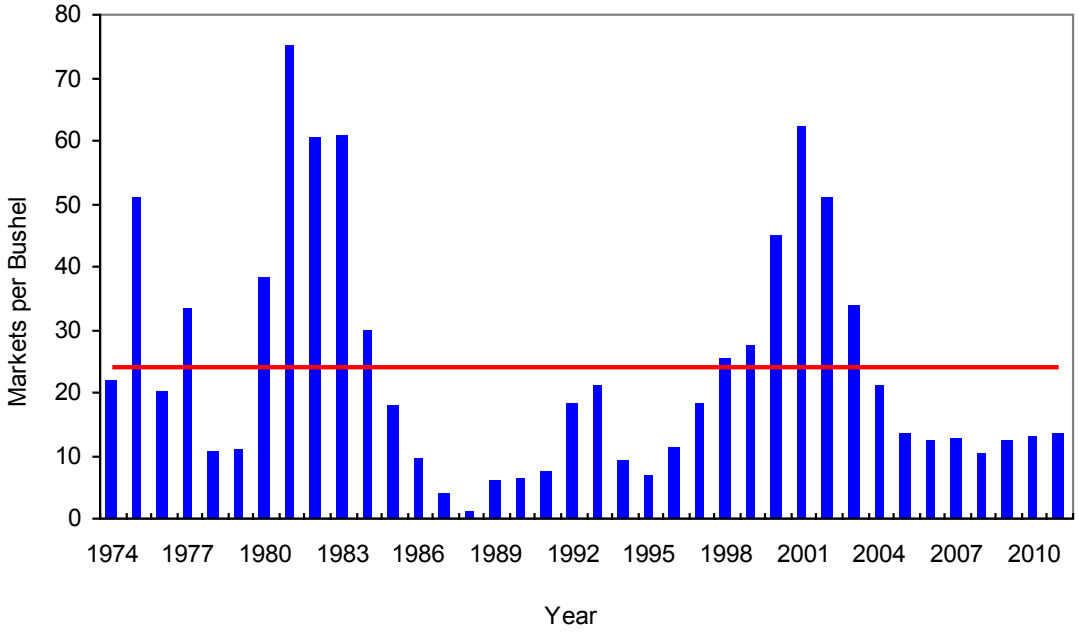

Figure 4. Mean number of market oysters per bushel derived from one bushel samples collected from the Ridge, 1974-2011.

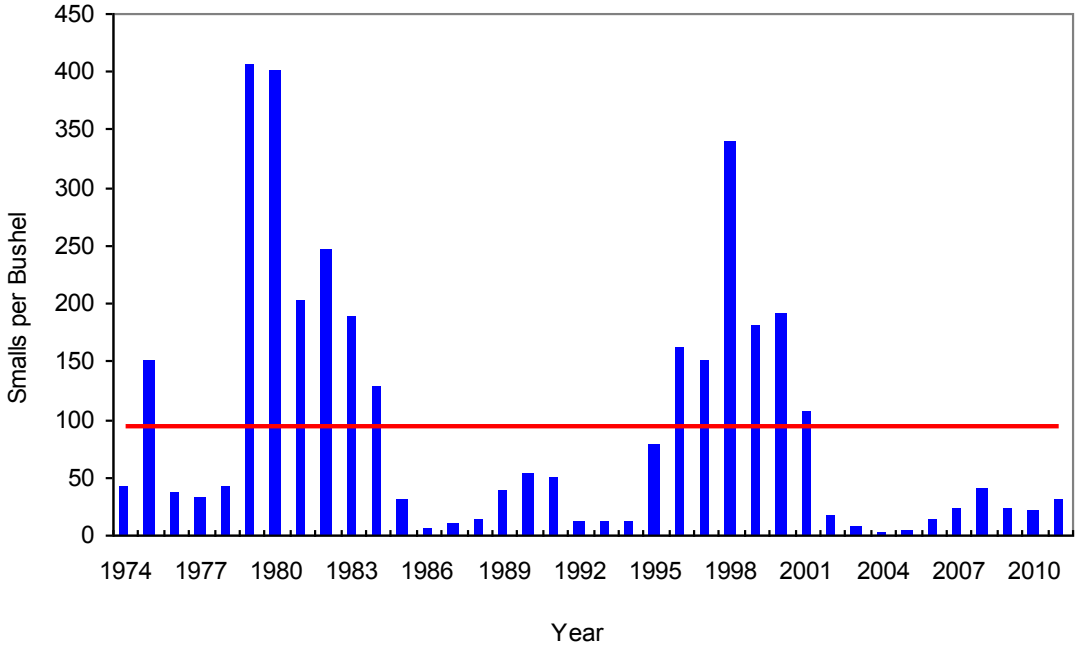

Figure 5. Mean number of small oysters per bushel derived from one bushel samples collected from the Ridge, 1974-2011.

The number of spat per bushel (4.7/bu.) remains well below the long term survey average (Figure 6). The number of boxes continues to be lower than the time series average which maybe a reflection of the low density of oysters rather than any definitive trends in disease activity (Figure 7).

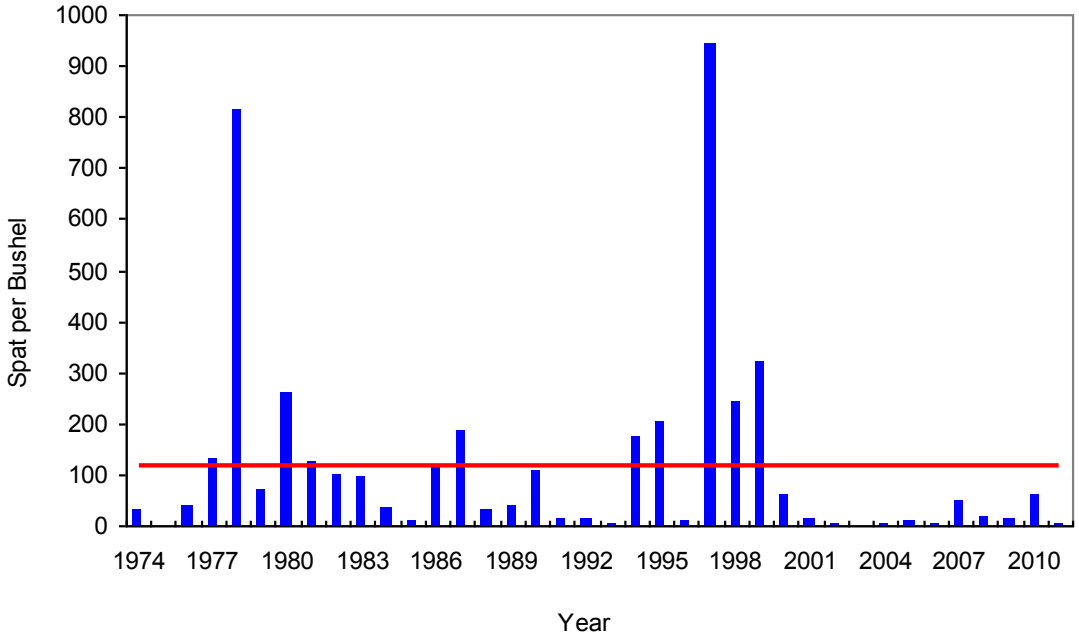

Figure 6. Mean number of spat per bushel derived from one bushel samples collected from the Ridge, 1974-2011.

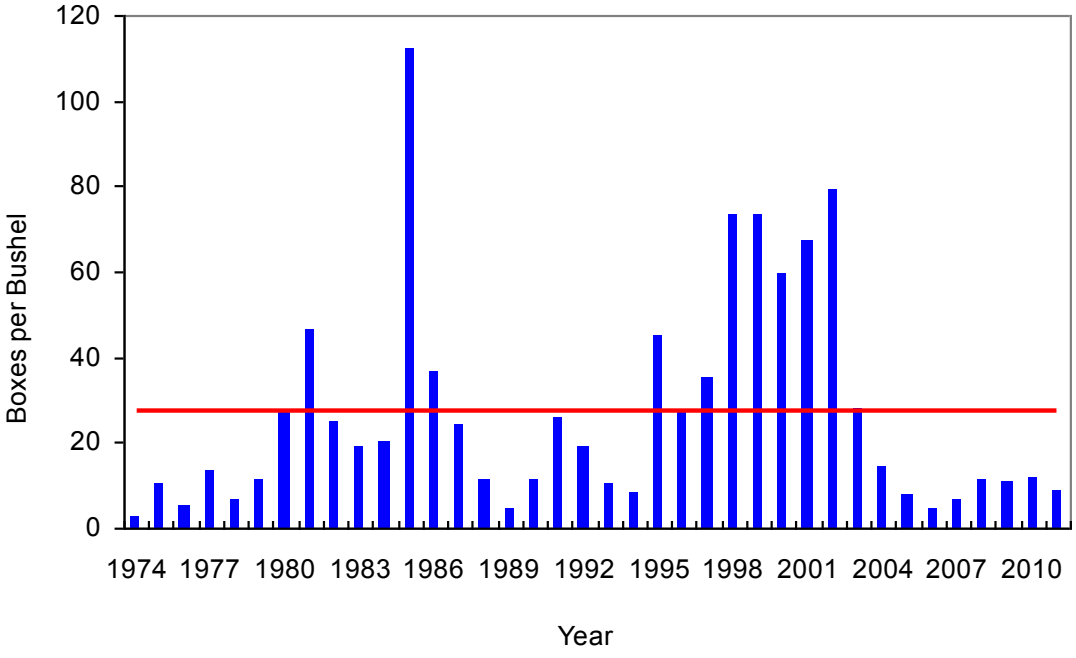

Figure 7. Mean number of boxes per bushel derived from one bushel samples collected from the Ridge, 1974-2011.

A total of 325 oysters were measured to determine height frequency distributions of oysters on the bed (Figure 8). Of the oysters that were measured an estimated 41.2% were above the 2 ¾" minimum size limit. This represents a decrease of 30% in the

number of marketable oysters when compared with the 2010 data. This decrease may be a result of the abundance of small oysters resulting from the recruitment event that occurred last year.

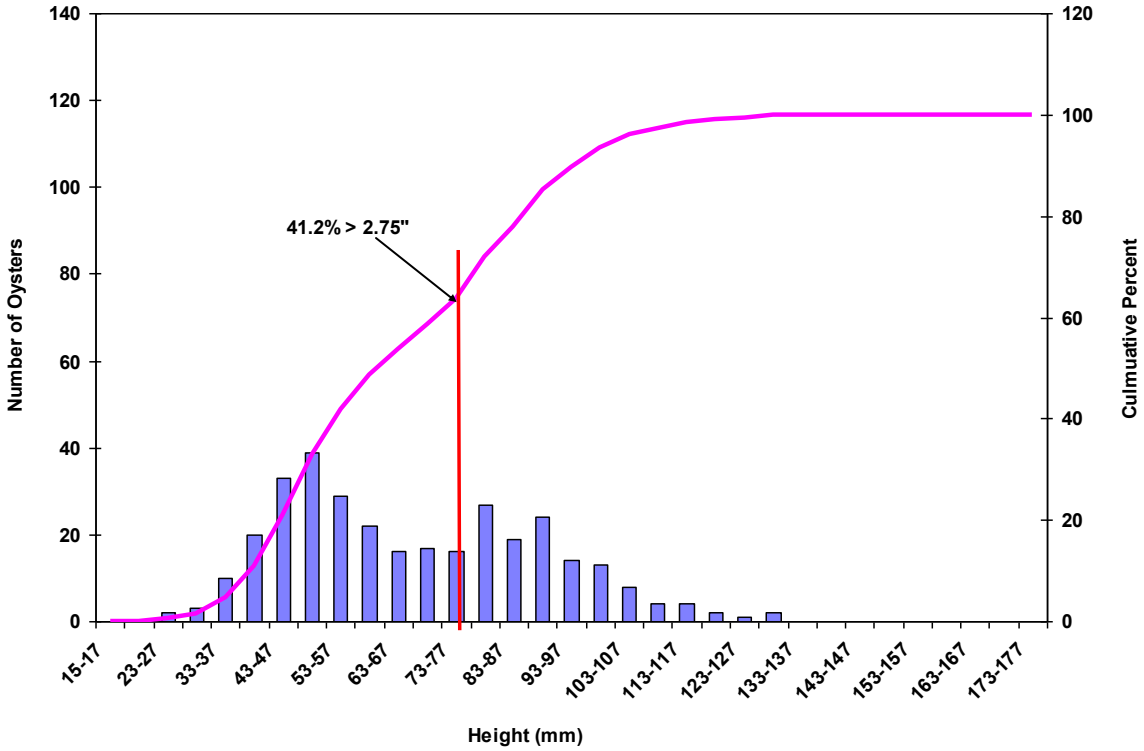

Figure 8. Height frequency of oysters collected from the Ridge in 2011.

Silver Bed

The Silver Bed is the largest of Delaware's natural seed beds. There was relatively low harvest (< 5%) from this bed during the first four years of the direct market fishery (Whitmore and Cole 2003; Whitmore and Greco 2005). This was most likely due to the abundance of small oysters, which were not suitable for harvest. The majority of harvest effort shifted to the Silver Bed in 2005 with the closure of the Ridge. Unlike in previous years, minimal effort was directed at the Silver Bed in 2011, based on preliminary data, accounting for 4% of the total harvest (DDFW 2012).

Data from the 2011 survey is listed in Table 3. The density of marketable oysters increased (28%) in 2011 and rose above the time-series average for the first time since 2008 (Figure 9). The increase in the number of marketable oysters recorded during the 2011 survey reflects the continued recruitment of the spat observed in the 2008 survey into the fishery. Recruitment of new oysters decreased 98% in 2011 again falling below time series average (Figure 10).

Table 3. Oyster stock density derived from one bushel samples collected from the Silver Bed in 2011.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	13	29	422	41	25
2	28	26	258	23	20
3	10	24	164	25	40
4	24	8	172	15	60
5	3	26	457	51	25
6	20	32	471	35	45
7	5	32	425	40	40
8	5	39	561	43	15
9	4	36	536	41	20
10	4	49	513	42	20
Avg.	11.6	30.1	397.9	35.6	31.0

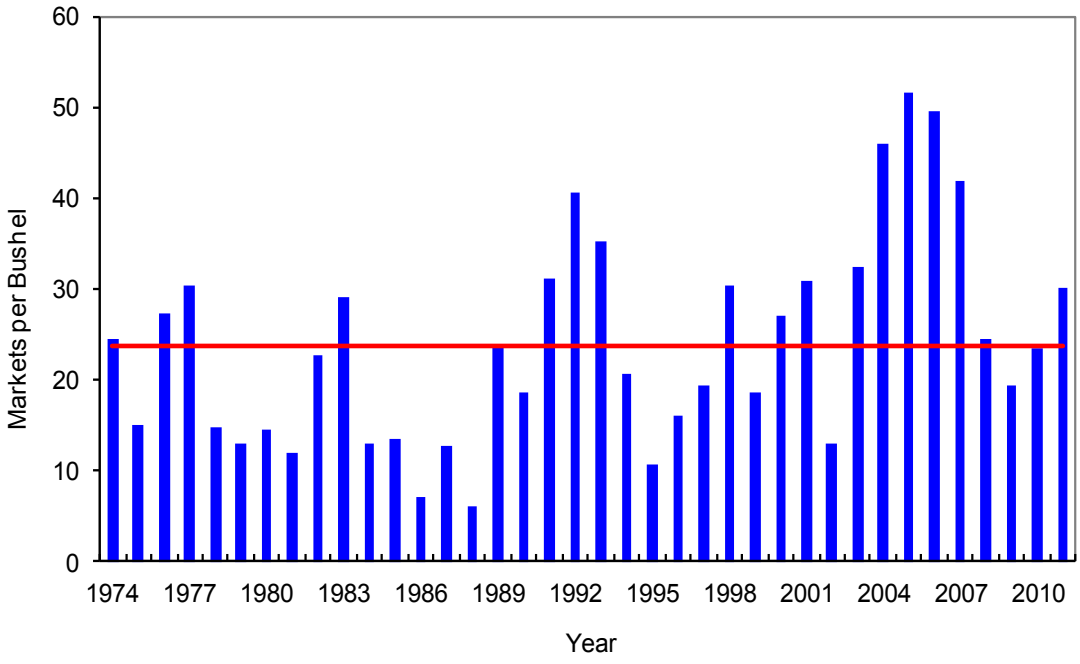

Figure 9. Mean number of market oysters per bushel derived from one bushel samples collected from the Silver Bed, 1974-2011.

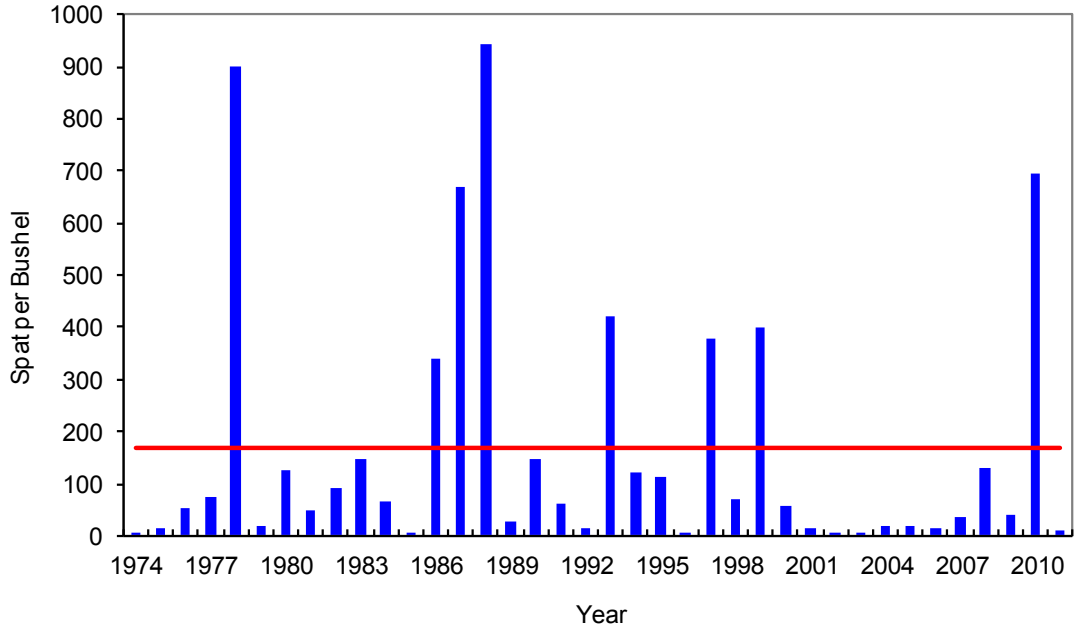

Figure 10. Mean number of spat per bushel derived from one bushel samples collected from the Silver Bed, 1974-2011.

The number of small oysters increased 419%, the highest level seen in the survey since 2001 (Figure 11). This increase in small oysters indicates that the 2010 year class sustained minimum mortality following the 2010 survey. Despite a 52% increase in the number of boxes, the number of boxes still remained below the time series average (Figure 12).

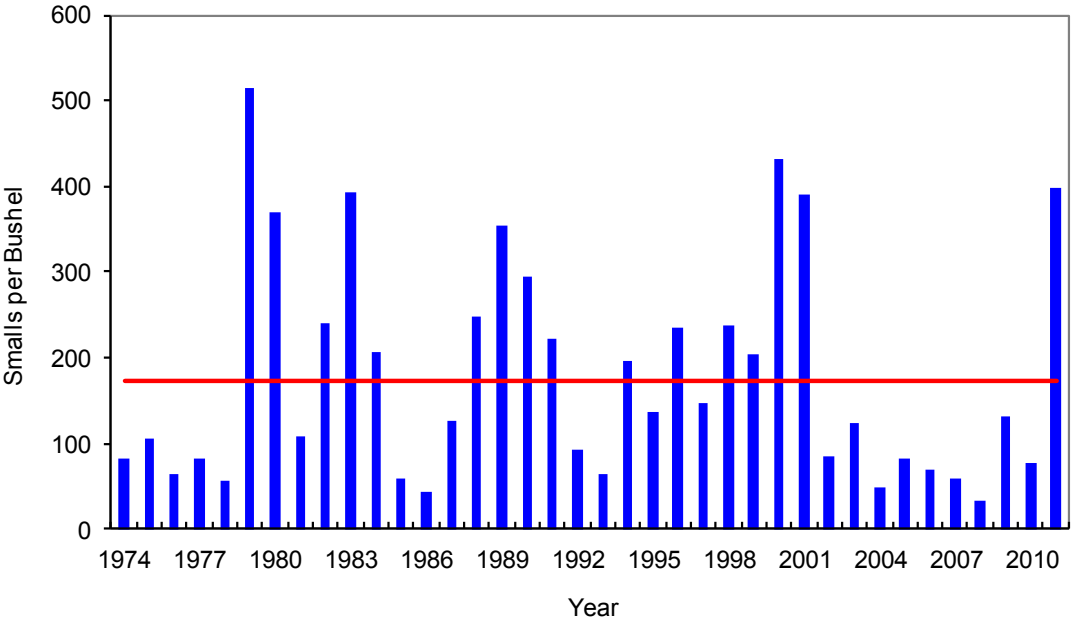

Figure 11. Mean number of small oysters per bushel derived from one bushel samples collected from the Silver Bed, 1974-2011.

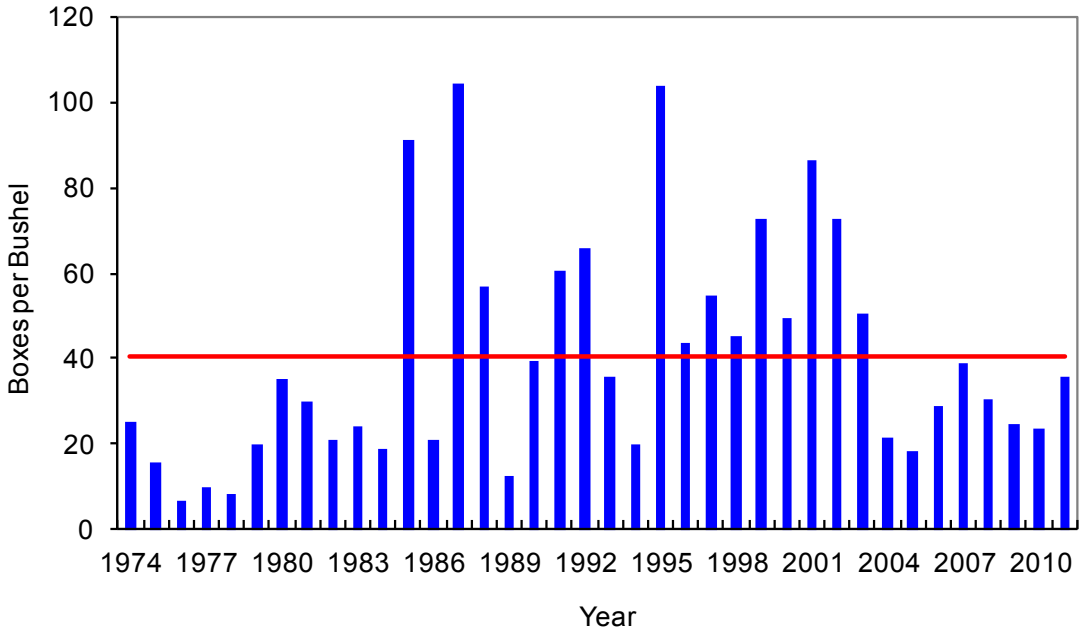

Figure 12. Mean number of boxes per bushel derived from one bushel samples collected from the Silver Bed, 1974-2011.

A height frequency distribution of oysters on the Silver Bed was generated from the survey and is depicted in Figure 13. A total of 676 oysters were measured with 12.3% of those over the 2 ¾" minimum size limit which is attributed to the significant increase in the abundance of small oysters in this year's survey.

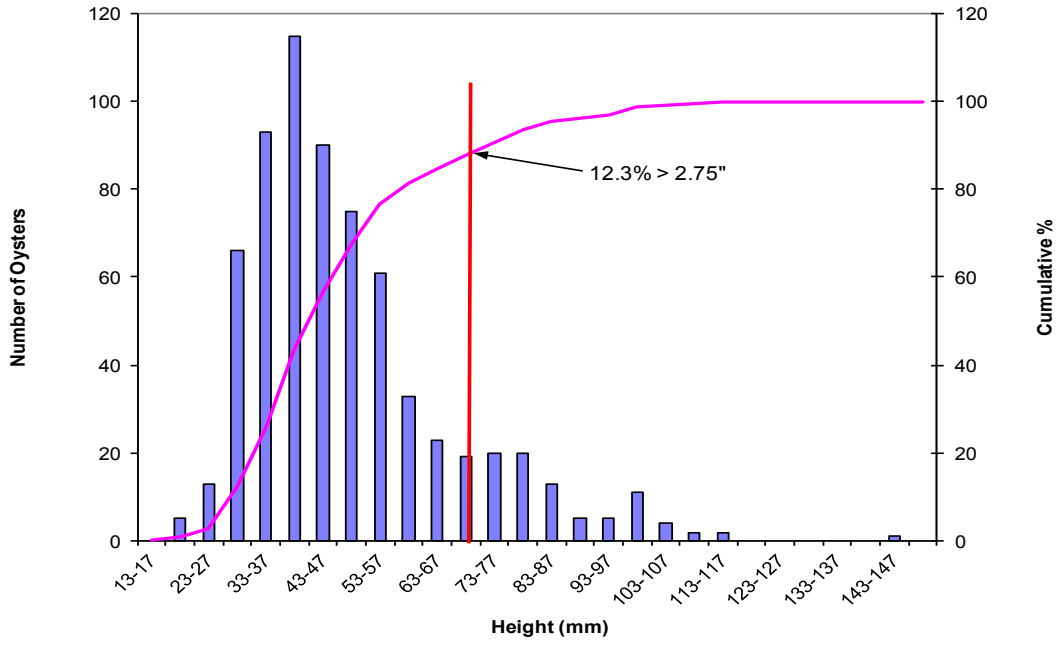

Figure 13. Height frequency of oysters collected from the Silver Bed in 2011.

Over-the-Bar

The Over-the-Bar bed is generally not considered a major seed bed since it is composed of long series of lumps that can be difficult for harvesting, especially during periods of relatively low stock densities (Cole 1988). Historically this bed has accounted for less than 10% of the annual harvest since the direct market fishery was instituted. Landings reports indicate that there was no effort directed on this area in 2011 (DDFW 2012). This year's survey data is listed in Table 4.

Table 4. Oyster stock density derived from one bushel samples collected from the Over-the-Bar Bed.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	1	25	157	22	55
2	4	60	276	39	30
3	2	55	195	39	35
4	7	50	153	33	45
5	4	33	137	34	55
6	3	36	217	31	35
Avg.	3.5	43.2	189.2	33.0	42.5

The number of market oysters per bushel increased 17% in 2011; the eleventh consecutive year above the time series average (Figure 14). There was an increase (225%) in the abundance of small oysters in 2011. This was the highest level since 2001 which was also the last time levels were above the time series average (Figure 15). This increase abundance of smalls can be attributed to the high abundance of spat observed in the 2010 survey. Spat recruitment decreased dramatically in 2011 to a record low level (Figure 16).

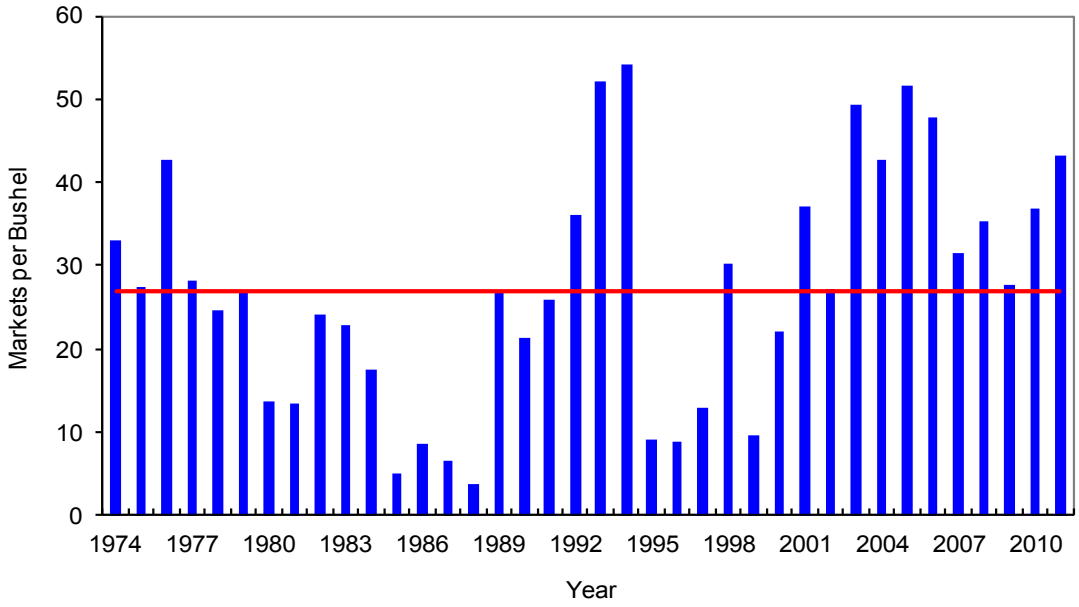

Figure 14. Mean number of market oysters per bushel derived from one bushel samples collected from Over-the-Bar, 1974-2011.

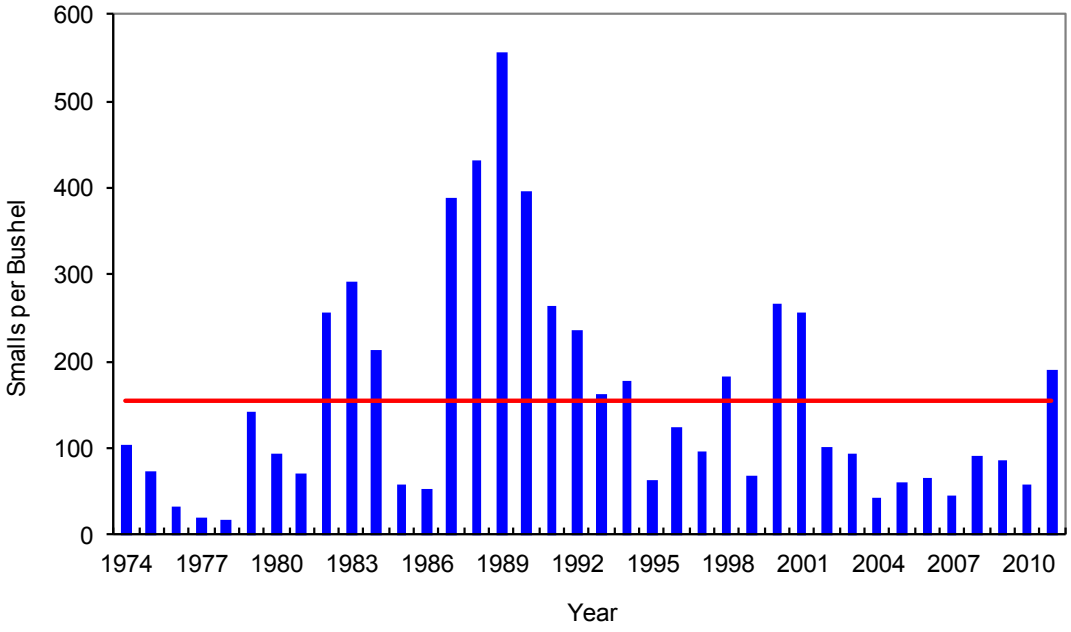

Figure 15. Mean number of small oysters per bushel derived from one bushel samples collected from Over-the-Bar, 1974-2011.

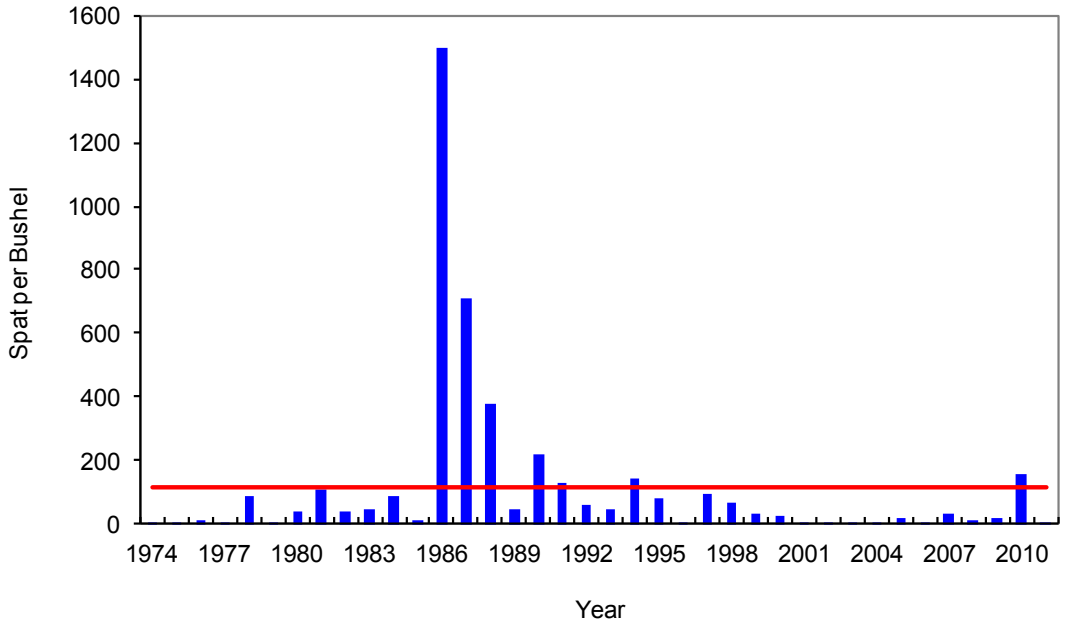

Figure 16. Mean number of spat per bushel derived from one bushel samples collected from Over-the Bar, 1974-2011.

Data in figure 17 shows that that number of boxes indicates that natural mortality decreased slightly in 2011 dipping slightly below time series average. Over 23% of those oysters, measured, were over the 2 ¾" minimum size limit (Figure 18). The decrease in the number of marketable oysters measured can be attributed to the increase in smalls oysters counted in this year's survey.

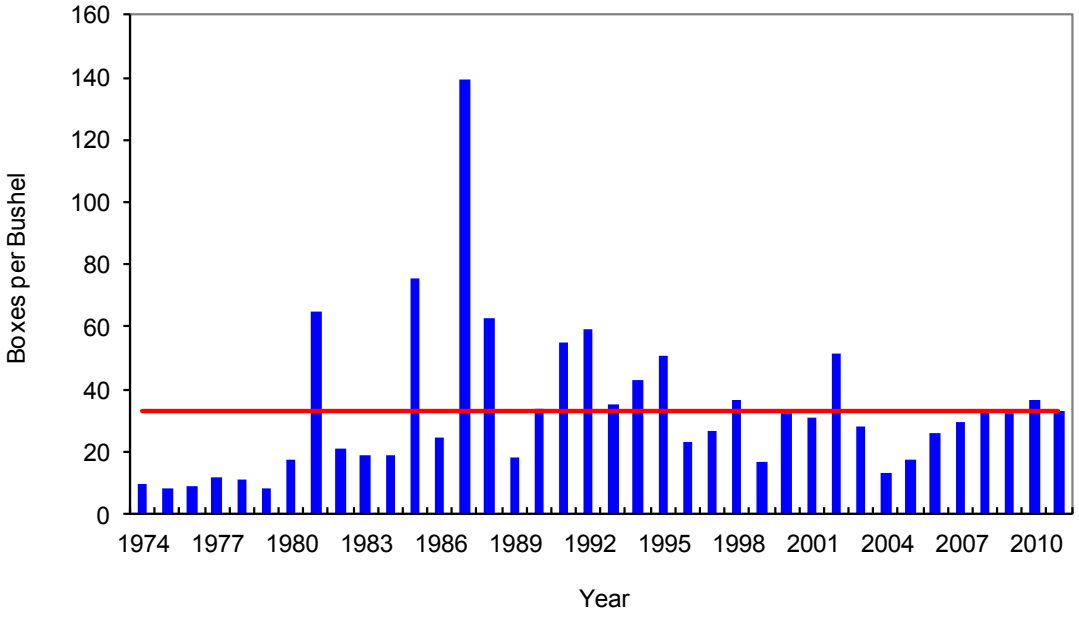

Figure 17. Mean number of boxes derived from one bushel samples collected from Over-the-Bar, 1974-2011.

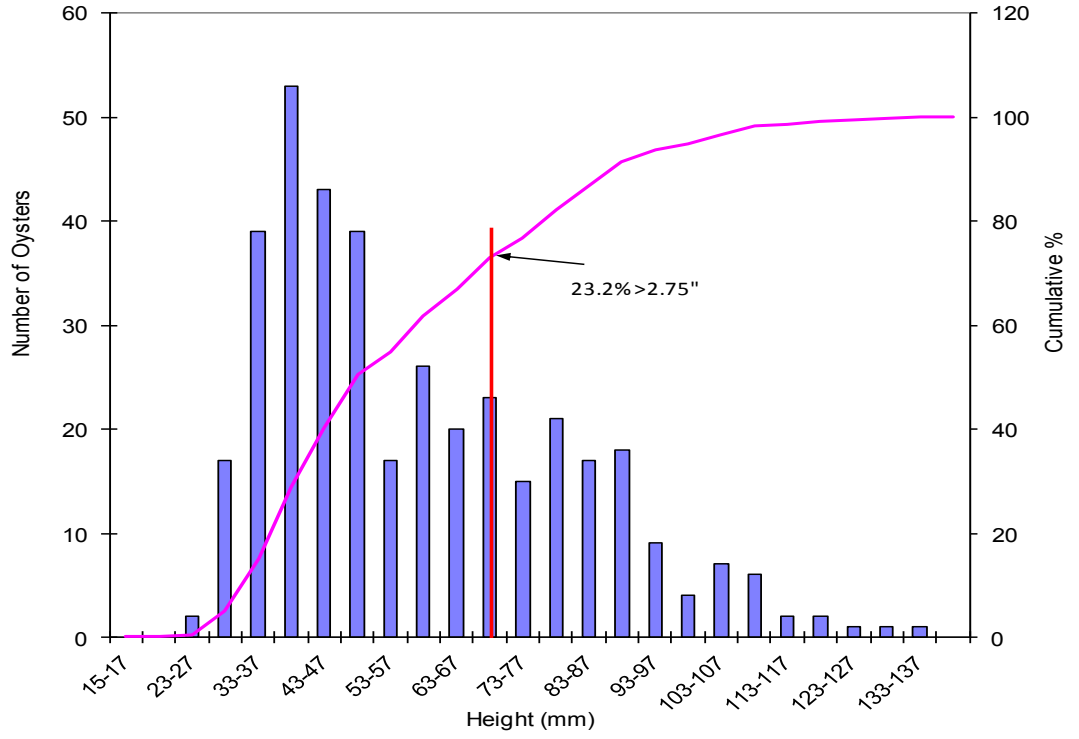

Figure 18. Mean height frequency of oysters collected from Over-the-Bar in 2011.

Drum Bed

Although the Drum Bed is one of the smallest seed beds, at times it can be an important supplemental source of high quality market oysters for the industry. Since the direct market fishery has been instituted, this bed annually accounts for less than 10% of the total landings (DDFW 2012). Survey data for the Drum Bed is listed in Table 5.

Table 5. Oyster stock density derived from one bushel samples collected from the Drum Bed.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	22	34	414	39	20
2	33	32	394	40	25
3	45	27	340	30	25
Avg.	33.3	31.0	382.7	36.3	23.3

The density of market oysters (31.0/bu.) was above the series average for the first time since 2006 and indicated a increase of 29% from 2010 (Figure 19). The abundance of small oysters (382.7/bu.) also increased in 2011 and was the highest level recorded since 1980 (Figure 20). Following the second highest level ever counted on the Drum Bed, recruitment decreased considerably in 2011. An average spat per bushel of 33.3 was similar to that seen in 2009 (Figure 21). The number of boxes per bushel fell slightly 4% in 2011, indicating, as with the Silver Bed, strong survivability of the 2010 year class (Figure 22). Based on height frequency data (Figure 23) 8% of the oysters measured were above the 2 ¾" minimum size limit.

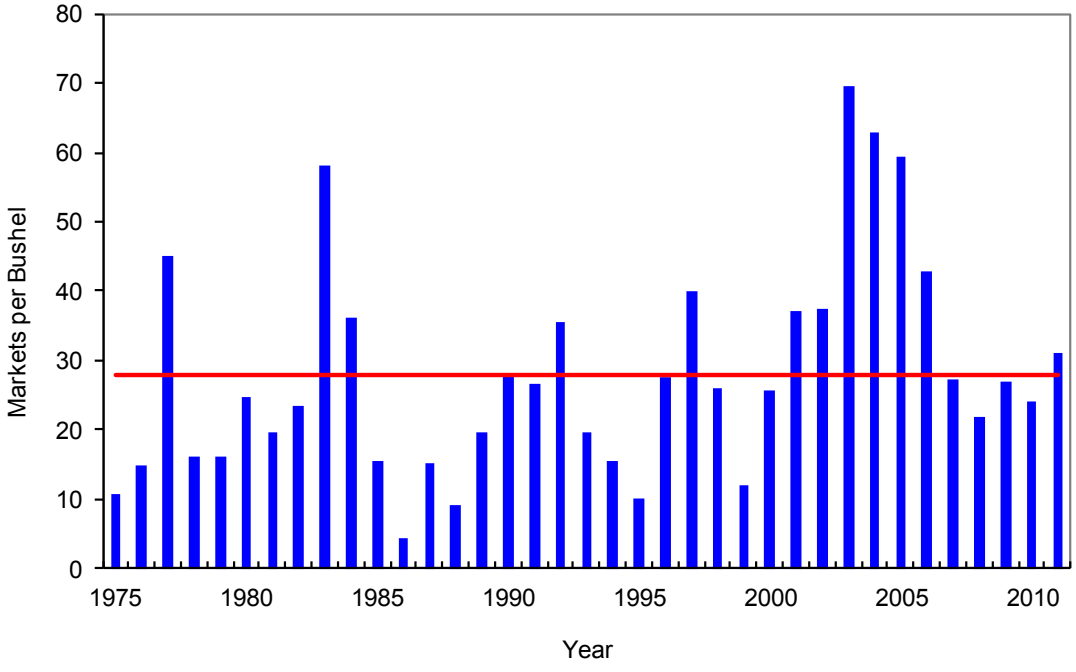

Figure 19. Mean number of market oysters per bushel derived from one bushel samples collected from the Drum Bed, 1975-2011.

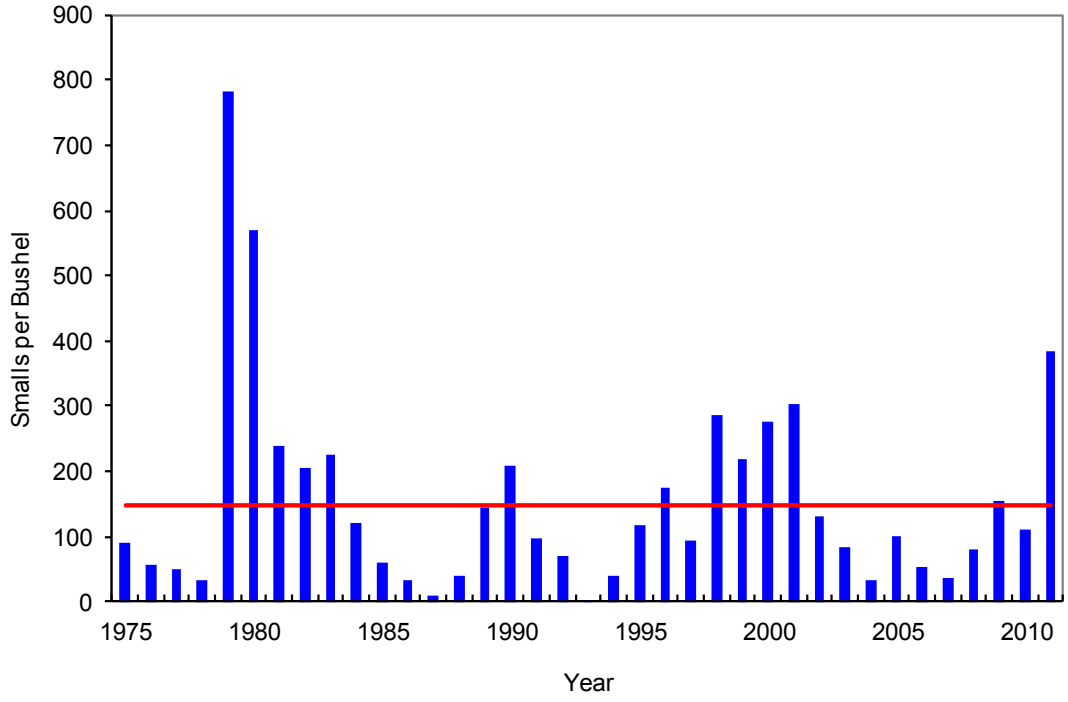

Figure 20. Mean number of small oysters per bushel derived from one bushel samples collected from the Drum Bed, 1975-2011.

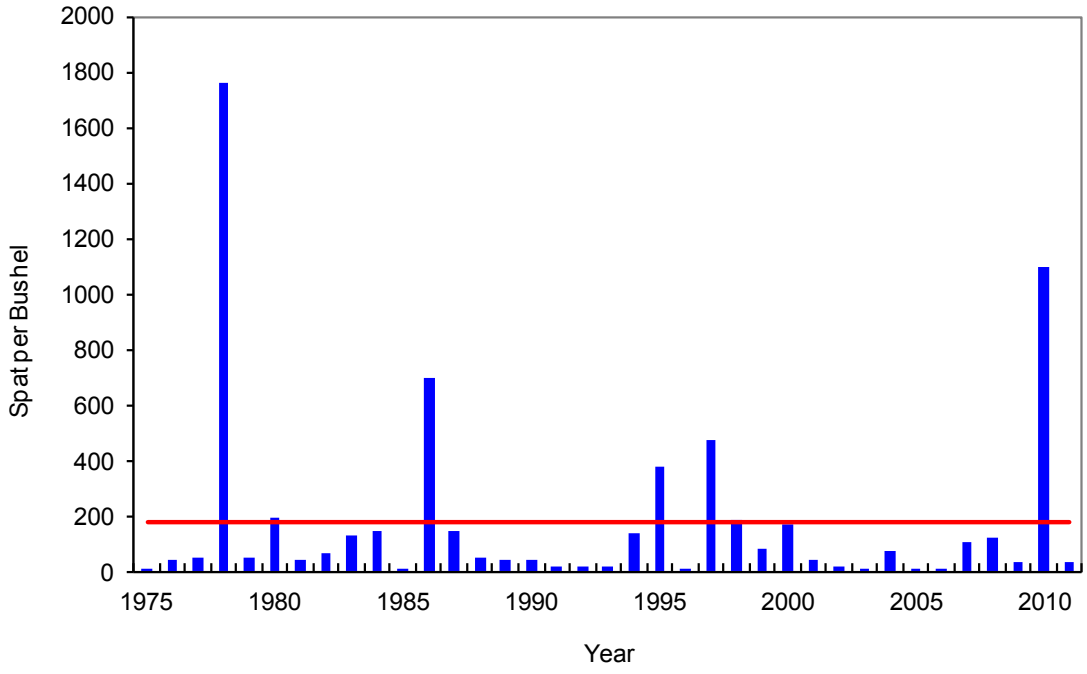

Figure 21. Mean number of spat per bushel derived from one bushel samples collected from the Drum Bed, 1975-2011.

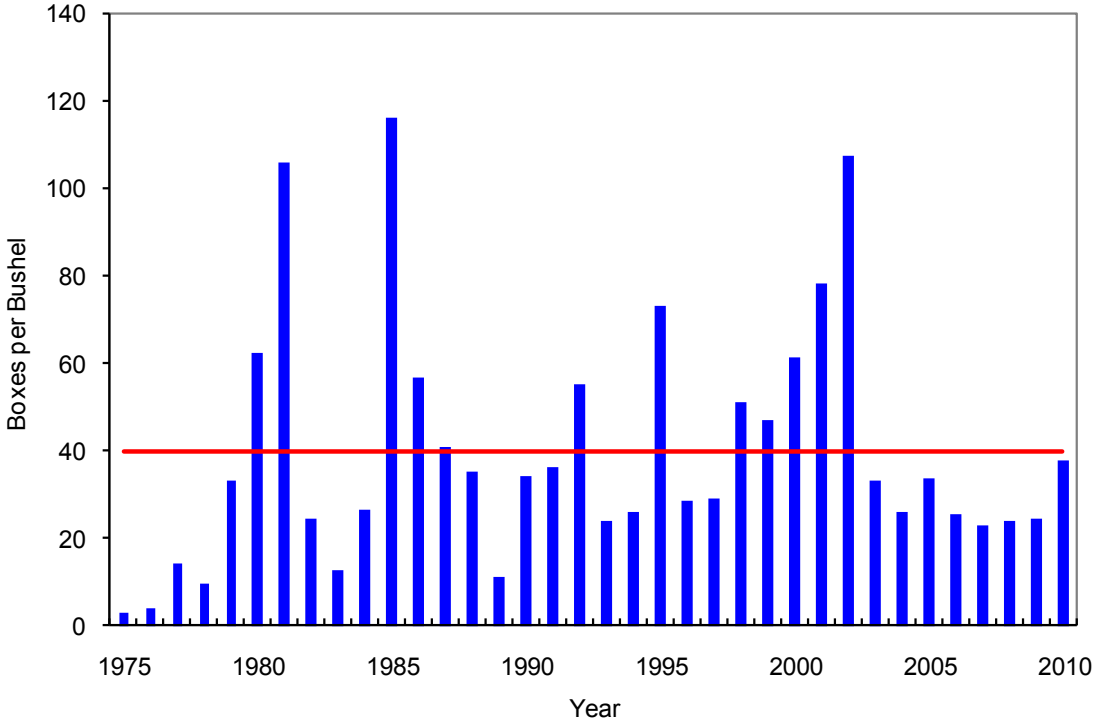

Figure 22. Mean number of boxes per bushel derived from one bushel samples collected from the Drum bed, 1975-2011.

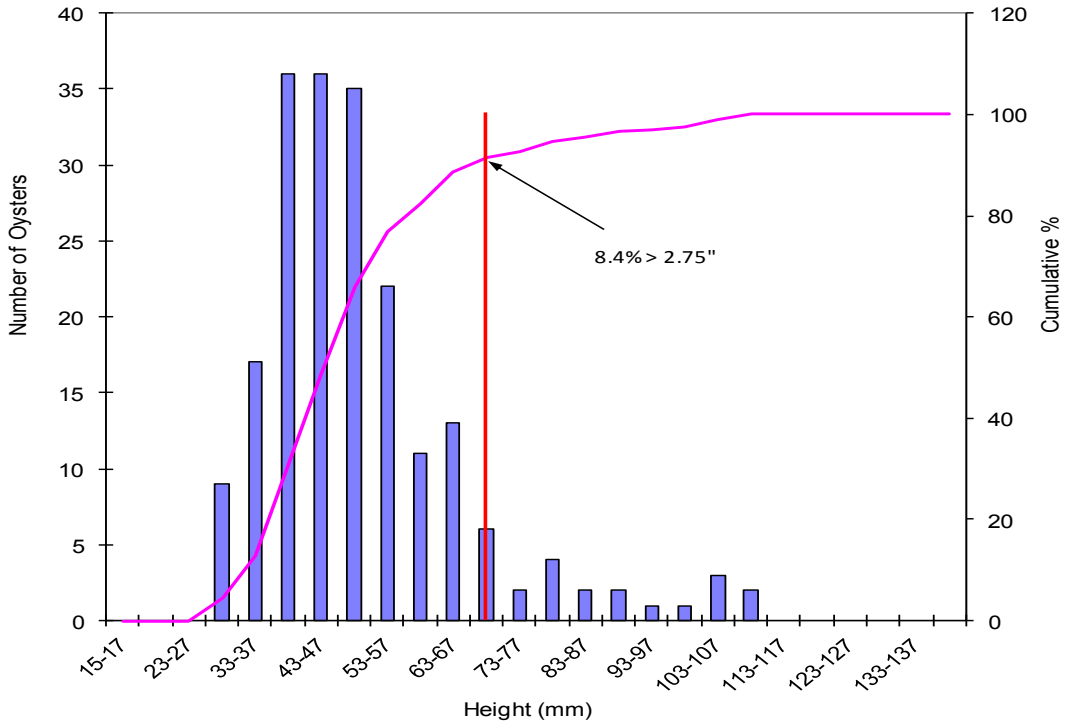

Figure 23. Height frequency of oysters collected from the Drum Bed in 2011.

Lower Middle

During the period 1980-85, the Lower Middle was an important seed producing area. During the period 2002-2004, the Lower Middle accounted for 31% of the total harvest, second only to the Ridge (Whitmore and Cole 2003; Whitmore and Greco 2005). Harvest levels declined to less than 5% of the total landings during the 2005-2007 seasons (Newlin, et al 2007, DDFW 2007). This area received the most effort in 2011, accounting for 46% of the total harvest (DDFW 2012). Inventory data from the Lower Middle is listed in Table 6.

Table 6. Oyster stock density derived from one bushel sample collected from the Lower Middle.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	6	37	178	13	40
2	4	34	192	28	40
3	6	57	192	17	40
4	6	19	114	24	45
5	9	27	472	35	5
6	9	47	410	43	15
Avg.	6.7	36.8	259.7	26.7	30.8

The number of market oysters per bushel (36.8/bu.), despite a 26% decrease, remained above the time series average for the eleventh straight year (Figure 24). Small oyster abundance increased markedly in 2011 and surpassed the average for the first time since 2001 (Figure 25). The number of new recruits (6.7/bu.) to the Lower Middle in 2011 was a 98% decrease from 2010 (Figure 26). Box counts remained relatively constant in 2011, remaining below average for the eighth consecutive year, suggesting that disease mortalities continue to remain relatively low at this site. (Figure 27). Examination of height frequency data showed that 21.5% of the measured oysters were over the 2 ¾" minimum harvestable size limit (Figure 28).

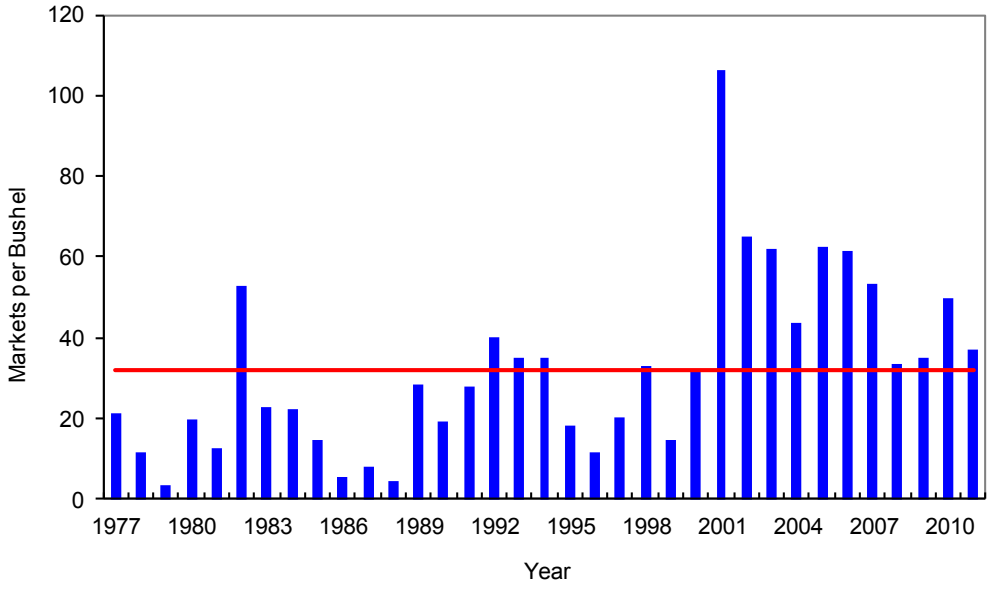

Figure 24. Mean number of market oysters per bushel derived from on bushel samples collected from the Lower Middle, 1977-2011.

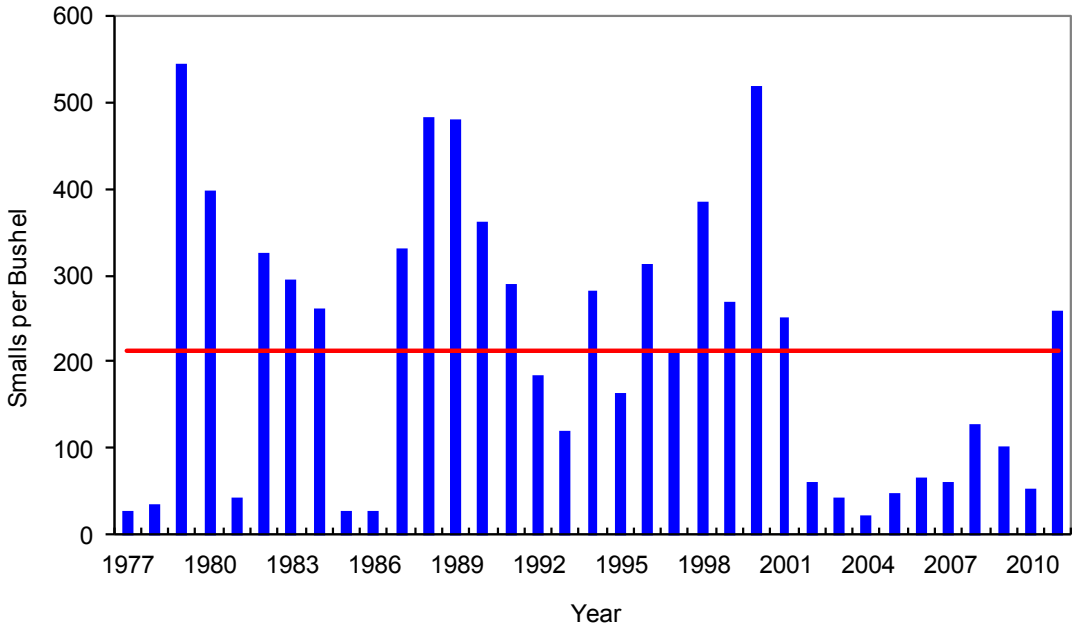

Figure 25. Mean number of small oysters per bushel derived from one bushel samples collected from the Lower Middle, 1977-2011.

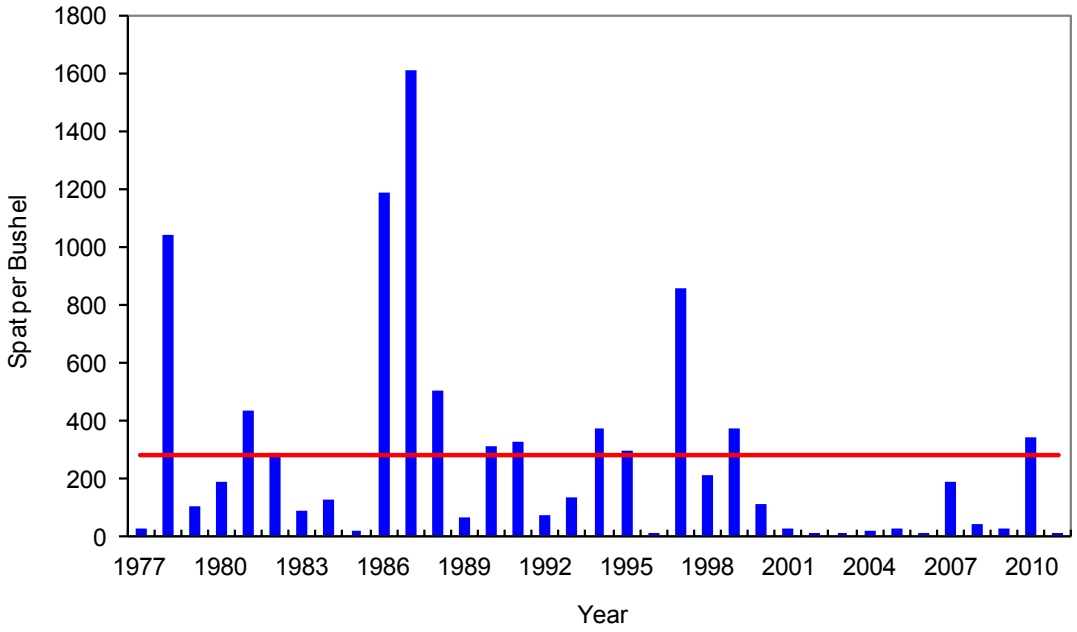

Figure 26. Mean number of spat per bushel derived from one bushel samples collected from the Lower Middle, 1977-2011.

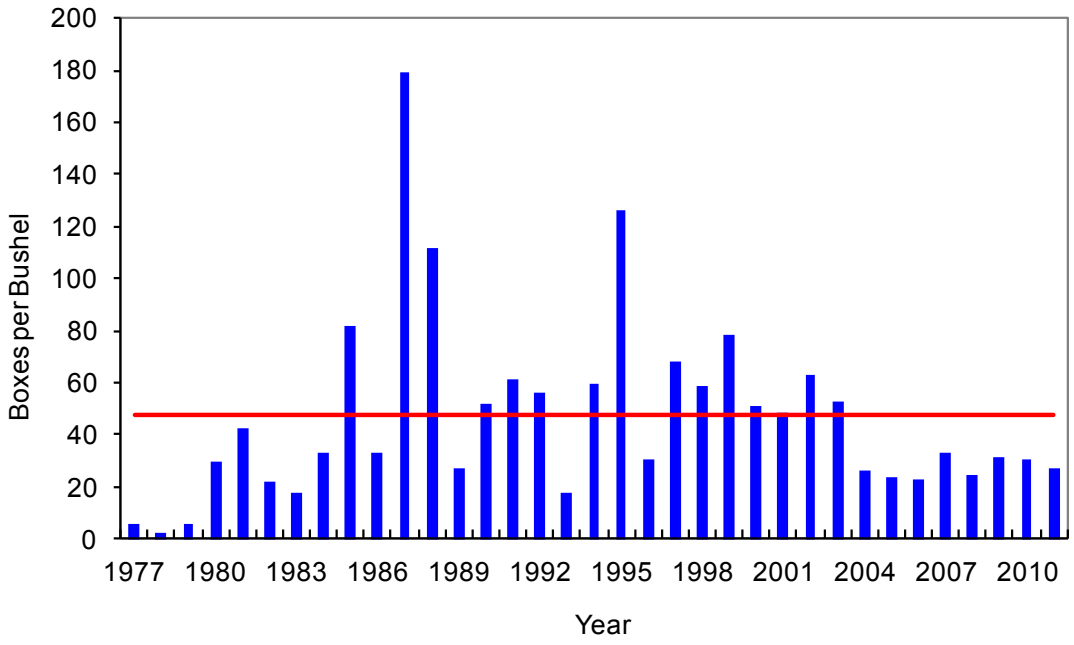

Figure 27. Mean number of boxes per bushel derived from one bushel samples collected from the Lower Middle, 1977-2011.

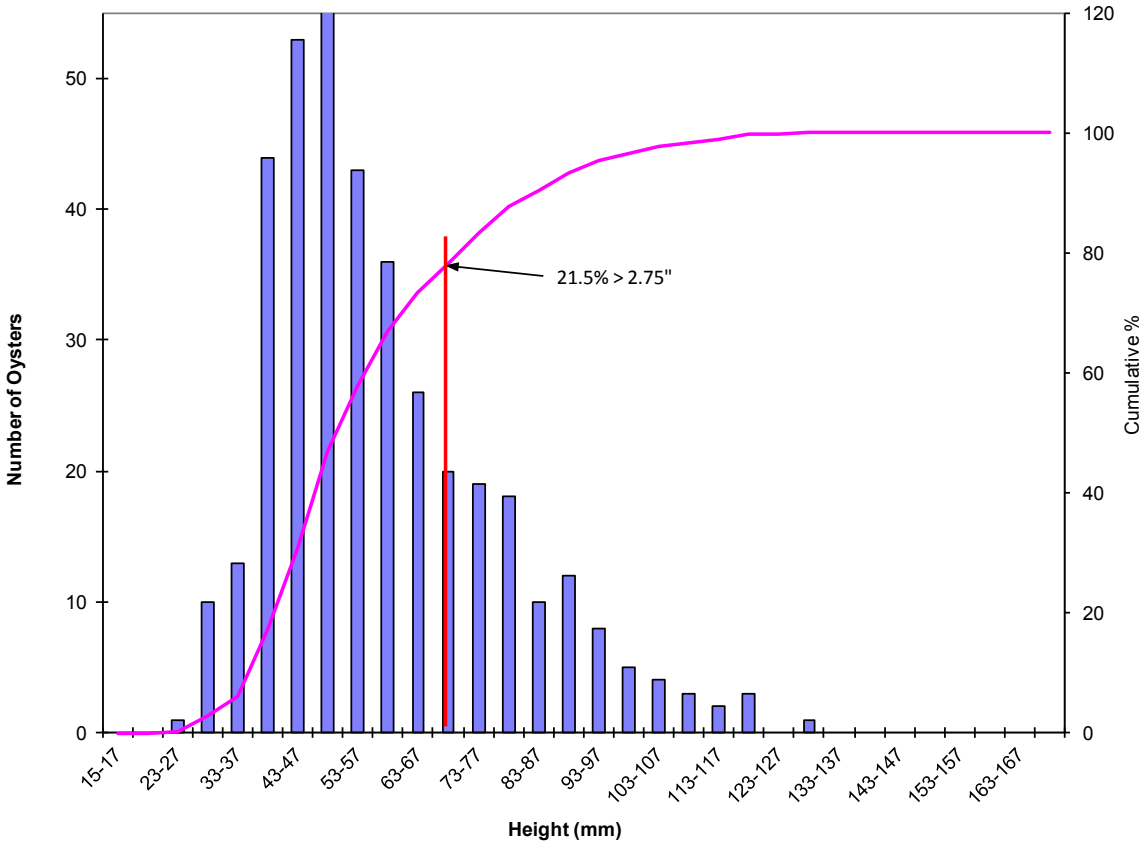

Figure 28. Height frequency of oysters collected from the Lower Middle in 2011.

Red Can

The Red Can is seldom used by harvesters because of its relatively small size and it's location in deep (30') water. Inventory data for 2011 is listed in Table 7. The number of market oysters per bushel declined 31% in 2011 compared to 2010 (Figure 29). For the second consecutive year there was an increase (49%) in the number of smalls per bushel (Figure 30). The number of new recruits for this area decreased markedly in 2011. The level of spat per bushel (6.7/bu.) was an 86% decrease from 2010 (Figure 31). The decrease in boxes suggests a slight decrease in natural mortality however, it remains around 10% (Figure 32).

Table 7. Oyster stock density derived from one bushel samples collected from the Red Can.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	1	1	3	0	98
2	18	25	113	19	55
3	12	23	87	11	60
Avg.	10.3	16.3	67.7	10.0	71.0

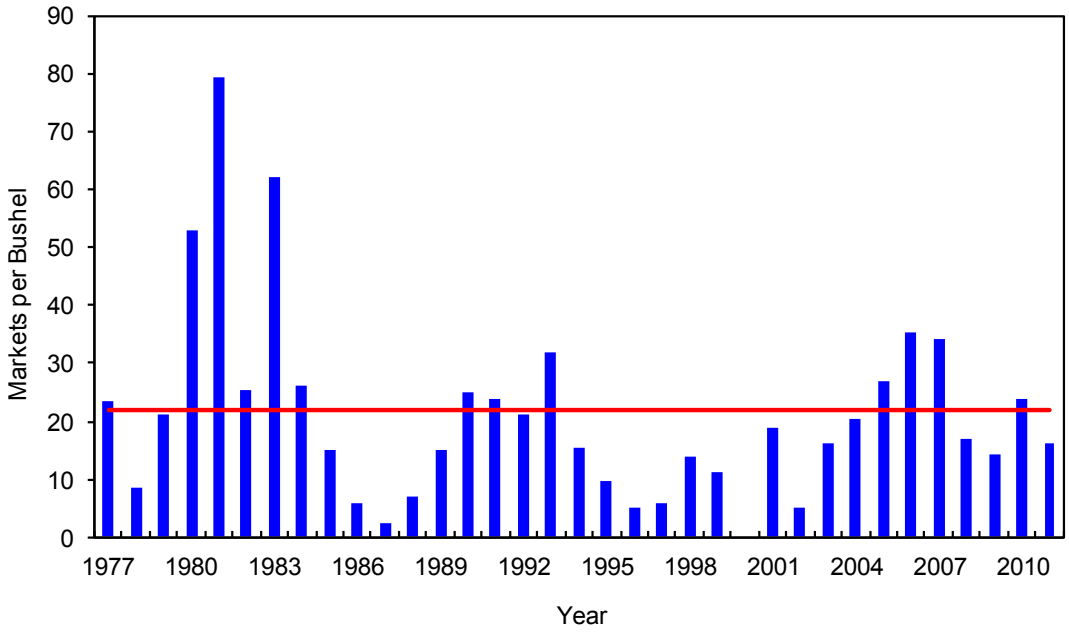

Figure 29. Mean number of market oysters per bushel derived from one bushel samples collected from the Red Can, 1977-2011.

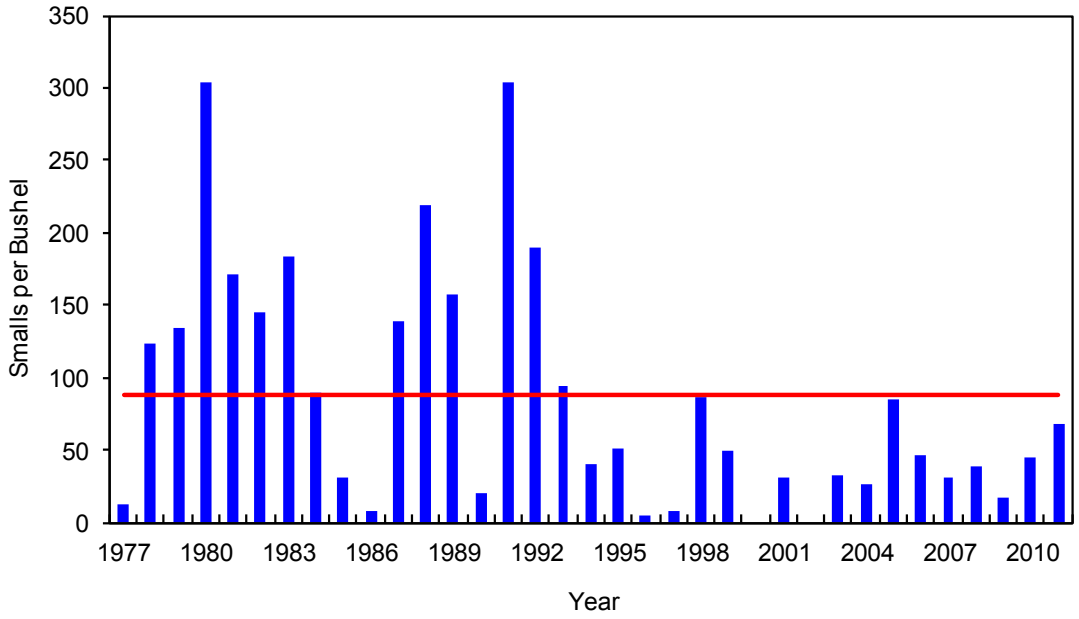

Figure 30. Mean number of small oysters per bushel derived from one bushel samples collected from the Red Can, 1977-2011.

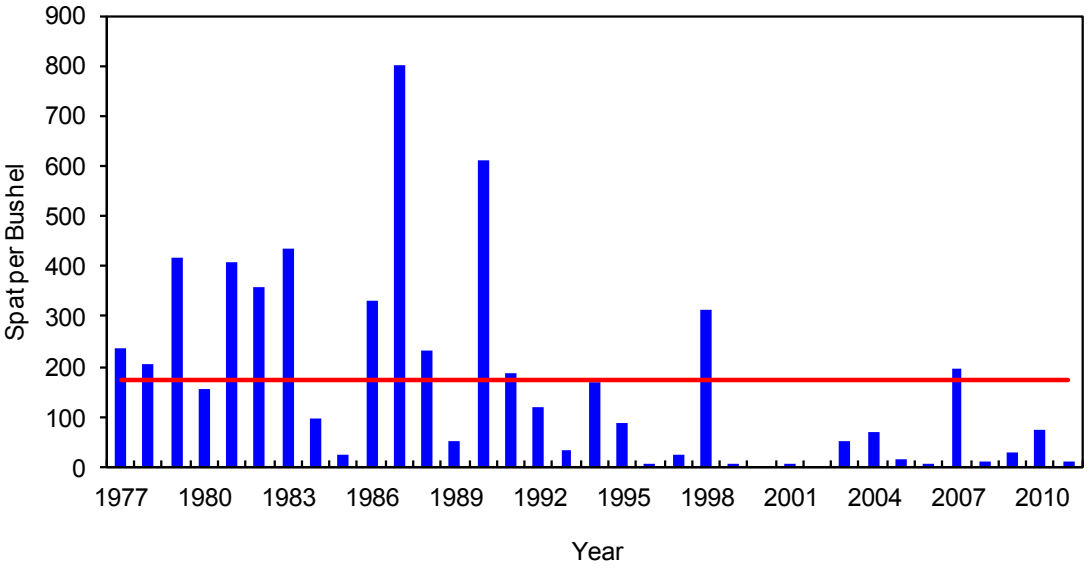

Figure 31. Mean number of spat per bushel derived from one bushel samples collected from the Red Can, 1977-2011.

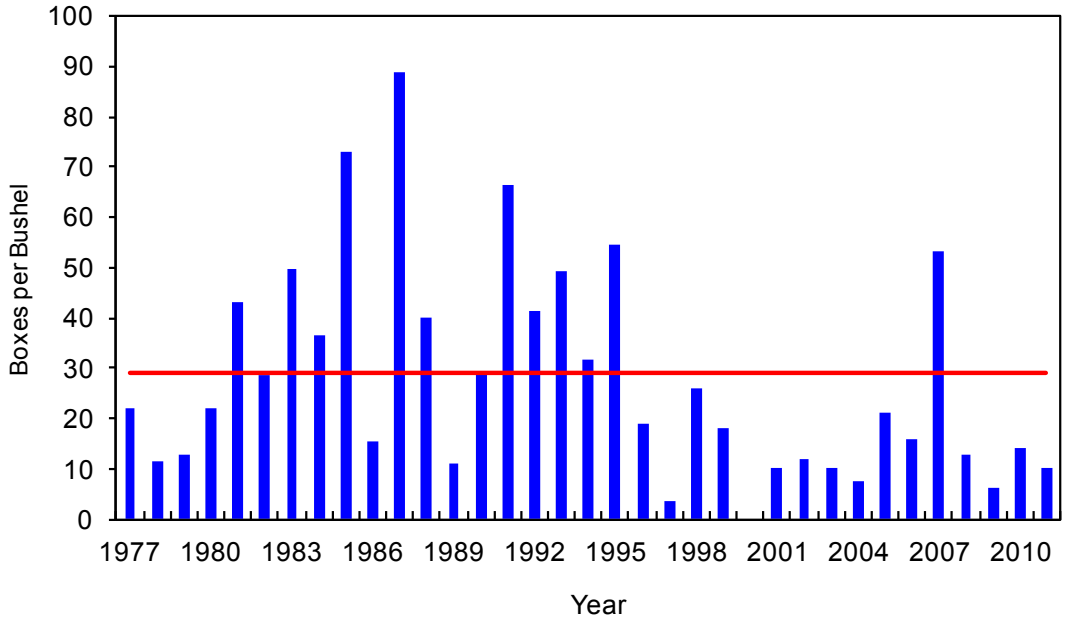

Figure 32. Mean number of boxes per bushel derived from one bushel samples collected from the Red Can, 1977-2011.

Woodland Beach

Historically, the Woodland Beach bed was sporadically used by harvesters due to its geographical location at the extreme northern limit of the seed beds; a major distance from the private planting grounds (Cole 1988). This area was last opened to harvest in 1985, when 3,000 bushels were harvested. In an effort to establish a major seed producing area in lower salinity waters, the state planted approximately 265,000 bushels of shell material adjacent to this bed in 1988. This area was reopened to harvest in 2006 and accounted for less than 1% of the total harvest (Newlin, et al. 2007). Preliminary data shows that less than 1% of the 2011 harvest occurred from this area (DDFW 2012). Inventory data from 2011 is listed in Table 8.

Table 8. Oyster stock density derived from one bushel samples collected from Woodland Beach.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	6	34	166	29	45
2	10	31	97	5	50
3	12	44	179	30	45
4	14	21	106	19	55
5	6	35	113	37	50
6	14	23	150	25	50
Avg.	10.3	31.3	135.2	24.2	49.2

Data from Table 8 and Figure 33 indicates that the 2011 number of markets per bushel remained steady at 31.3/bu. The density of small oysters, despite a 25% increase in abundance, continues to be well below the historical average (Figure 34). Box counts increased nearly 4% but remain below the long term average (Figure 35), and indicated a mortality rate of 13%. Generally, low salinities at this site restrict the impacts of disease (Dermo, MSX) and prohibit oyster drills from becoming a factor in natural mortality. Spat count data in Figure 36 indicates a decline in recruitment for the second straight year and remains below the time for the thirteenth consecutive year. Height frequency data in Figure 37 indicates that 25% of the population continues to be over the 2 ¾" minimum size limit.

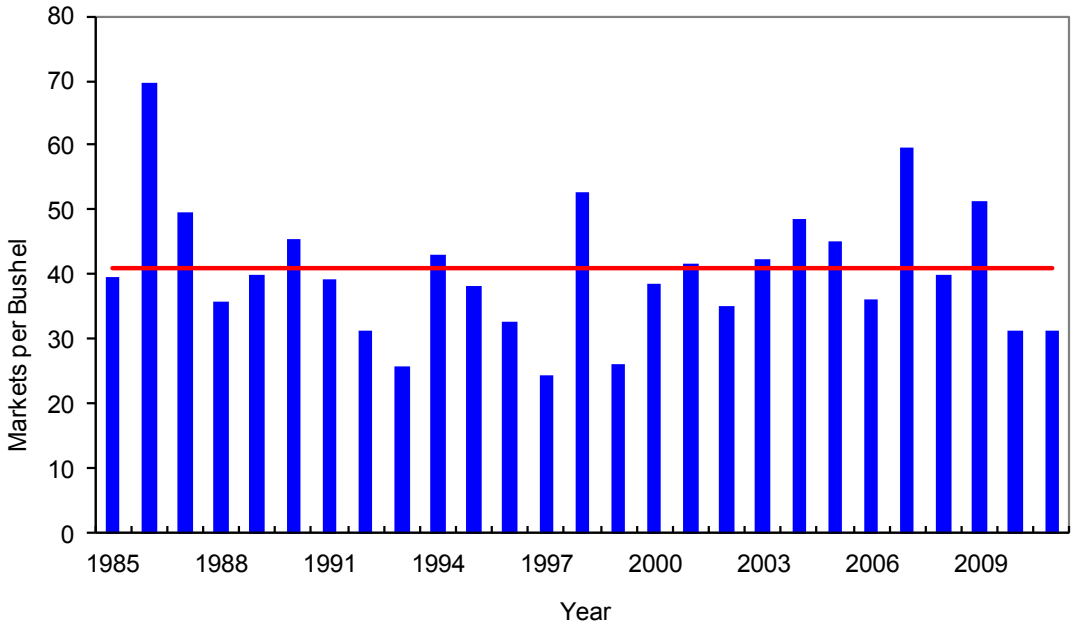

Figure 33. Mean number of market oysters per bushel derived from one bushel samples collected from Woodland Beach, 1985-2011.

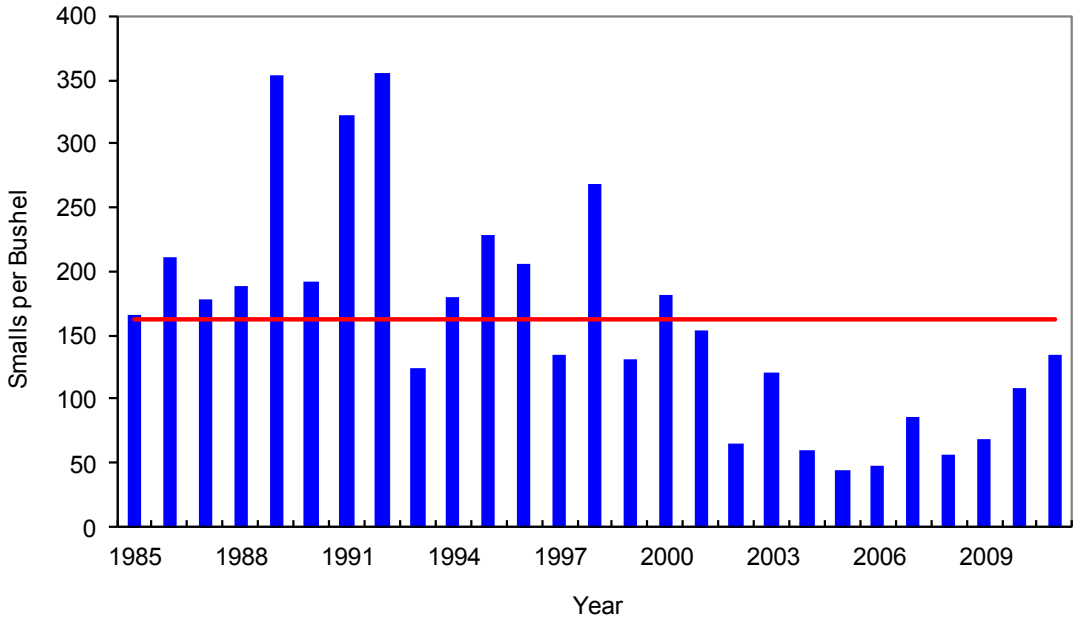

Figure 34. Mean number of small oysters per bushel derived from one bushel samples collected from Woodland Beach, 1985-2011.

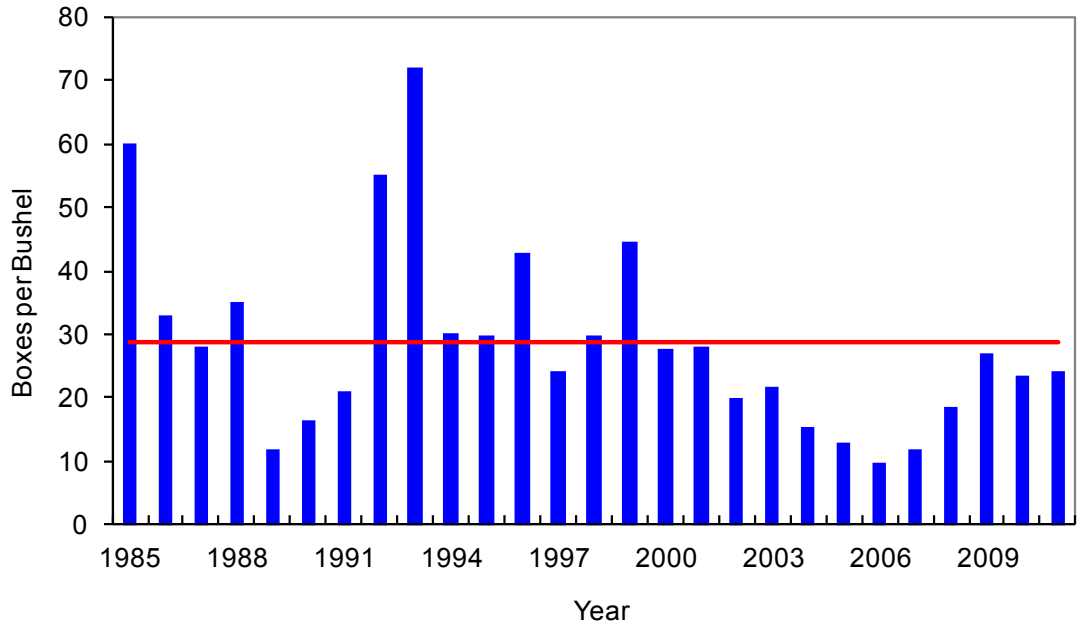

Figure 35. Mean number of boxes per bushel derived from one bushel samples collected from Woodland Beach, 1985-2011.

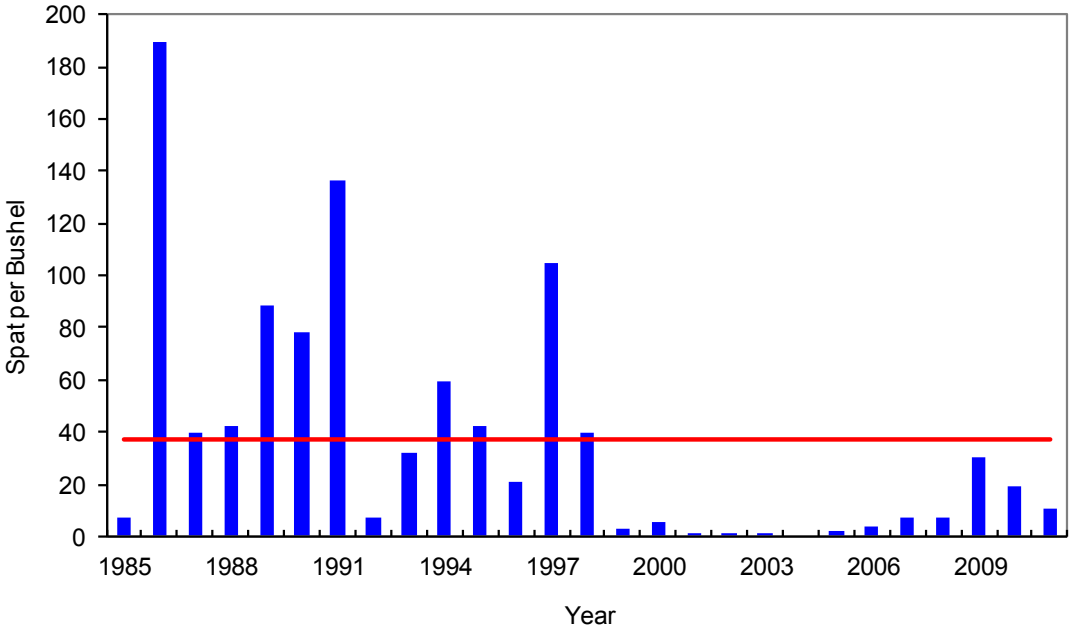

Figure 36. Mean number of spat per one bushel sample derived from one bushel samples collected from Woodland Beach, 1985-2011.

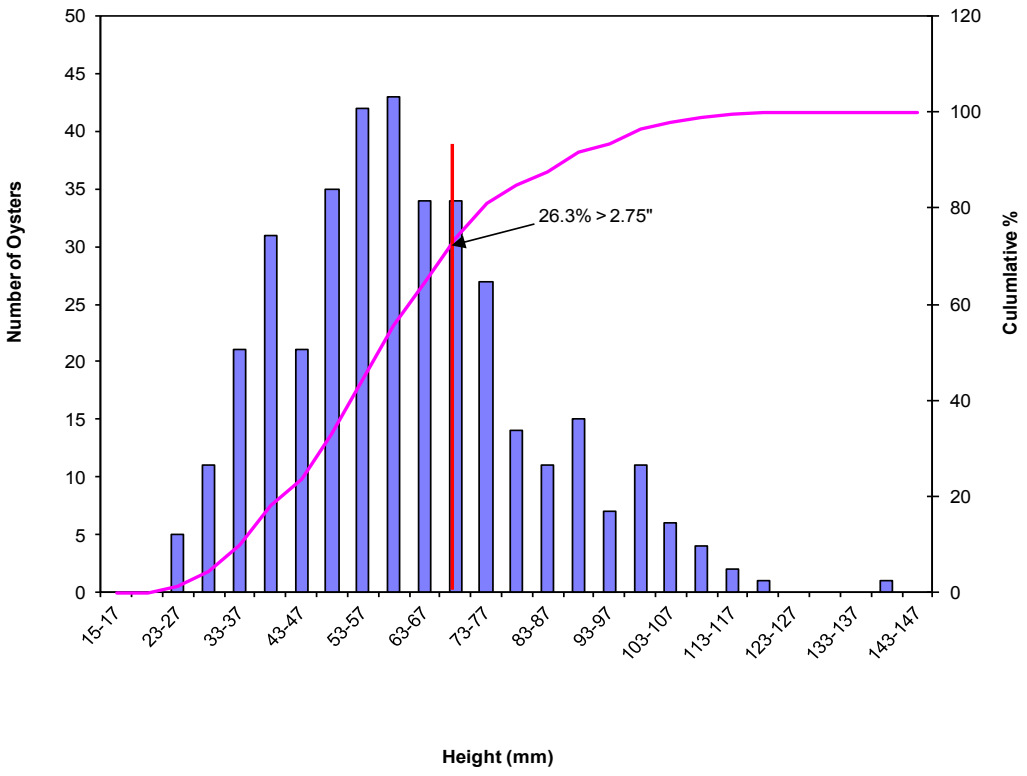

Figure 37. Height frequency of oysters collected from Woodland Beach in 2011.

Persimmon Tree

The Persimmon Tree bed has never been used as a primary seed harvesting site. However, it's location in the extreme upper portion of the Delaware Bay makes it ideal for future seed production (Cole 1988).

Data in Table 9 showed that the number of market oysters increased 90% in 2011. The abundance of small oysters also increased, 212%, from the 2010 survey. Spat recruitment decreased 80 and continues to remain low in 2011. Box counts indicated that natural mortality increased to be around 19% in 2011.

Table 9. Oyster stock density derived from one bushel samples collected from the Persimmon Tree Bed in 2011.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	10	37	158	41	50
2	2	37	132	45	60
Avg.	6.0	37.0	145.0	43.0	55.0

Leipsic River

The abundance of small oysters per bushel (58.5/bu.) was a 47% increase from the 2011 survey (Table 10 and Figure 38). The number of market oysters decreased again (69%) in 2011, remaining below the time series average (Figure 39). Recruitment of new oysters to this area averaged 6.3/bu. (Table 10, Figure 40). Box count data rose 8% in 2011 and remained below the time series average (Figure 41).

Table 10. Oyster stock density derived from one bushel samples collected from the Leipsic River in 2011.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	7	10	77	17	55
2	9	5	68	16	70
3	6	1	82	19	85
4	3	0	7	1	98
Avg.	6.3	4.0	58.5	13.3	77.0

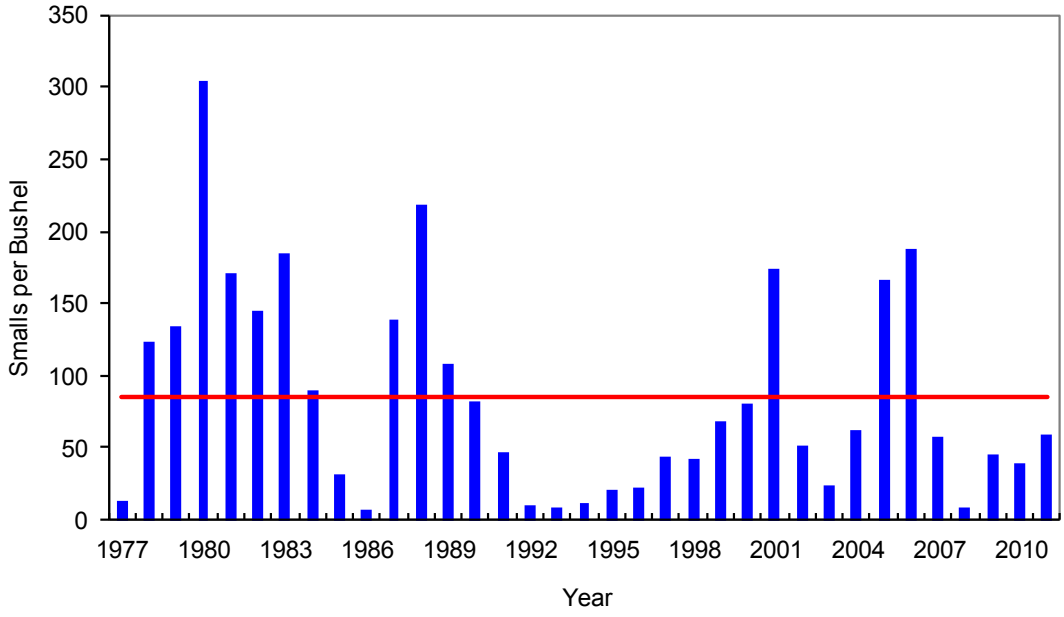

Figure 38. Mean number of small oysters per bushel derived from one bushel samples collected from the Leipsic River, 1977-2011.

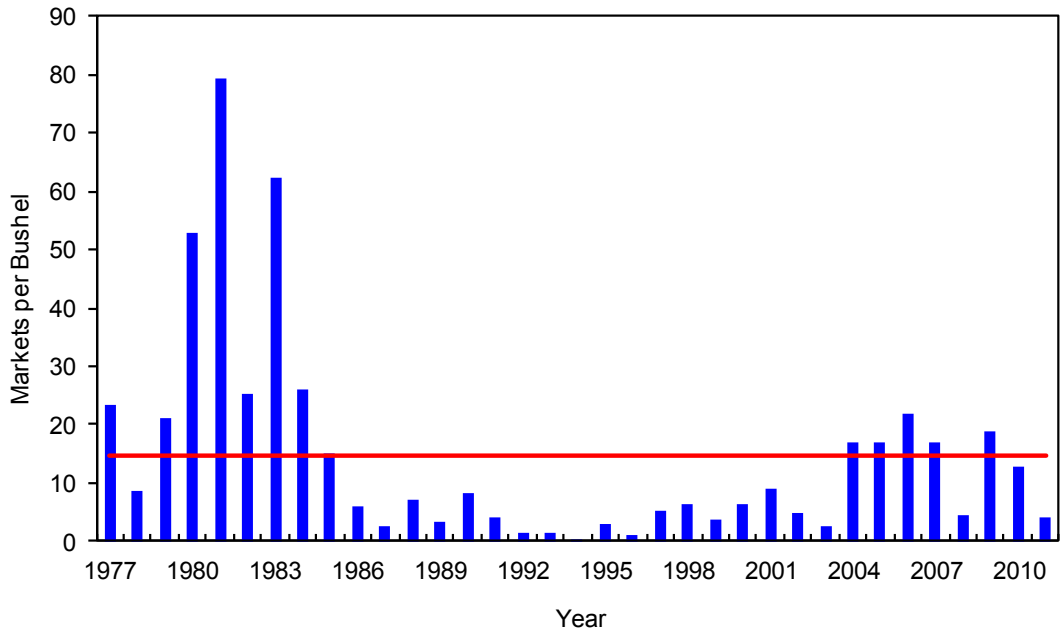

Figure 39. Mean number of market oysters per bushel derived from one bushel samples collected from the Leipsic River, 1977-2011.

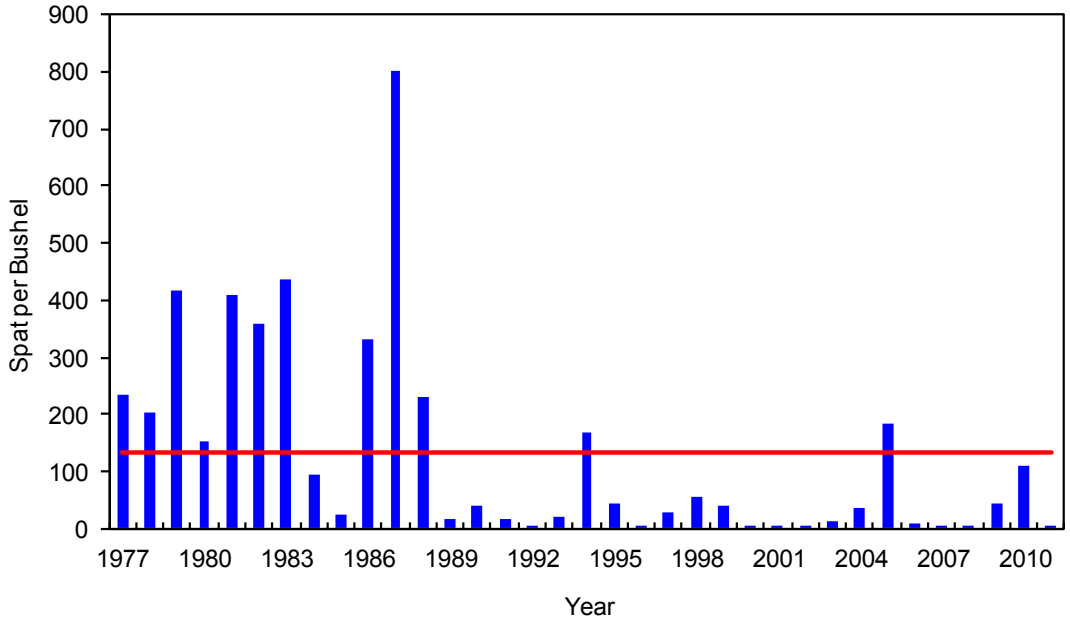

Figure 40. Mean number of spat per bushel derived from one bushel samples collected from the Leipsic River, 1977-2011.

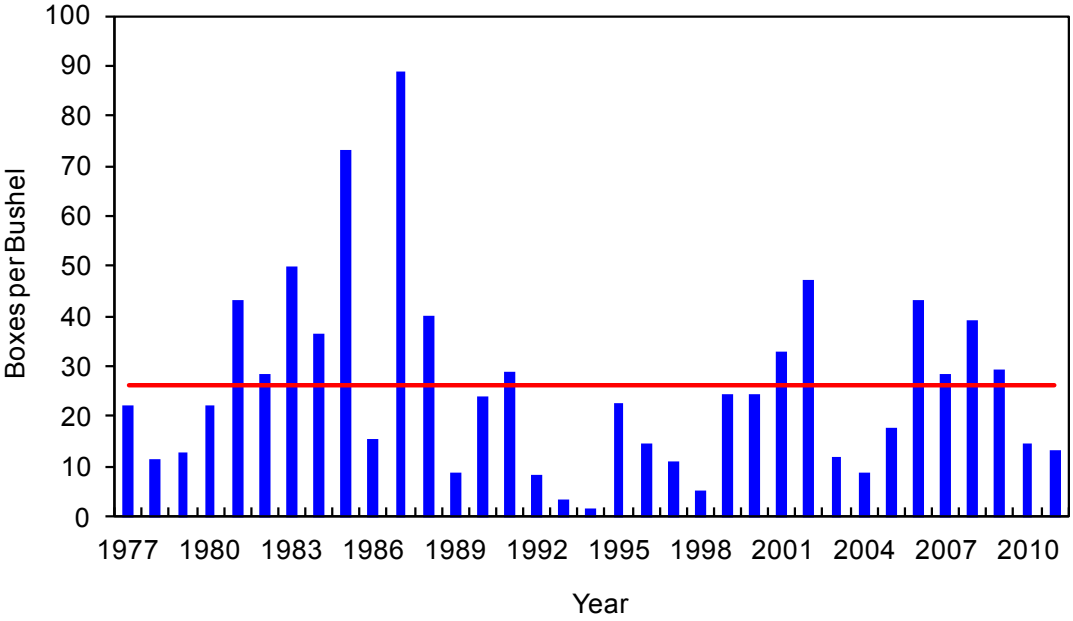

Figure 41. Mean number of boxes per bushel derived from one bushel samples collected from the Leipsic River, 1977-2011.

Pleasonton's Rock

Pleasonton's Rock was not considered a major seed bed when the State conducted the transplant fishery. Harvesters did, however, rely upon this area during periods of low stock densities to supplement their annual harvest (Cole et al. 1987). This area was last surveyed by the Division in 1986, when stock densities were at record low levels. Until 2005, there had not been any documented harvest from this bed. Upon talking to harvesters and witnessed harvest activity on this site during the 2005 season, it was decided to once again include Pleasonton's Rock as part of the annual survey.

Abundance data for the area is listed in Table 11. The number of markets increased 12% from levels observed in 2010. Historical data suggests that although the 2011 number of markets per bushel is around the recent average, current levels are well above levels observed 20-30 years ago (Figure 42). The abundance of small oysters, 331.3 smalls per bushel, was a significantly increase from the previous year and is the highest level recorded during years in which this area was surveyed and could be attributed to the abundance of spat recorded in 2010 (Figure 43). Spat recruitment decreased markedly (98%) in 2011, the lowest level since 2006 (Figure 44). Based on the height frequency data collected, 17.7% of the population is over the 2 ¾" minimum size limit indicative of the increase in abundance of markets oysters counted in this year's survey (Figure 45).

Table 11. Oyster stock density derived from one bushel samples collected from Pleasonton's Rock in 2011.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	7	28	244	47	45
2	25	36	370	47	35
3	18	27	380	33	30
Avg.	16.7	30.3	331.3	42.3	36.7

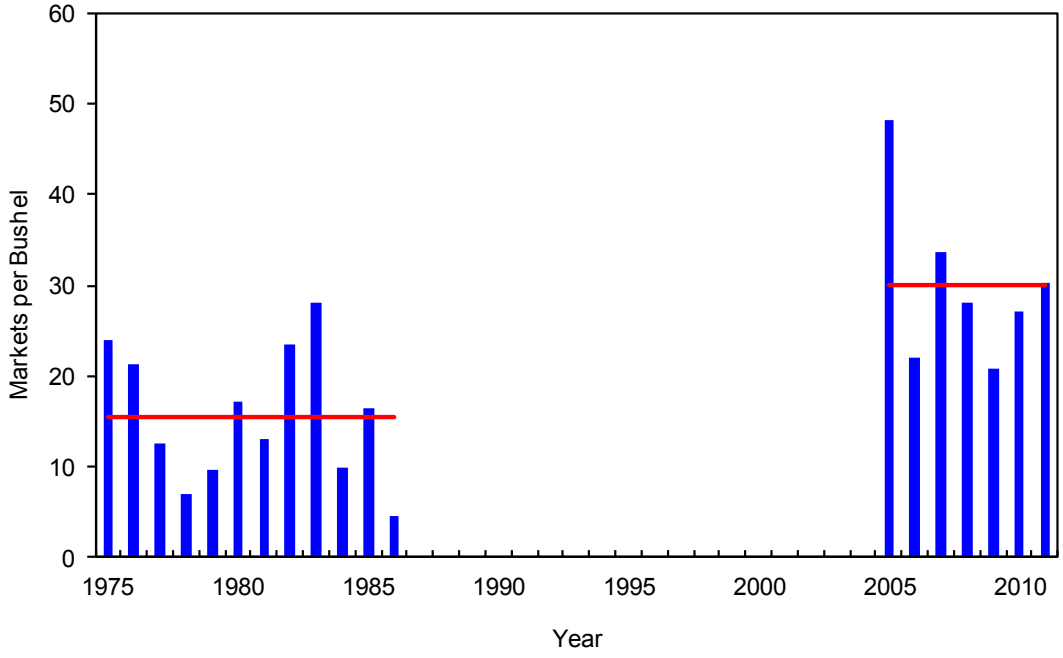

Figure 42. Mean number of markets oysters per bushel derived from one bushel samples collected from Pleasonton's Rock, 1975-86 and 2005-2011.

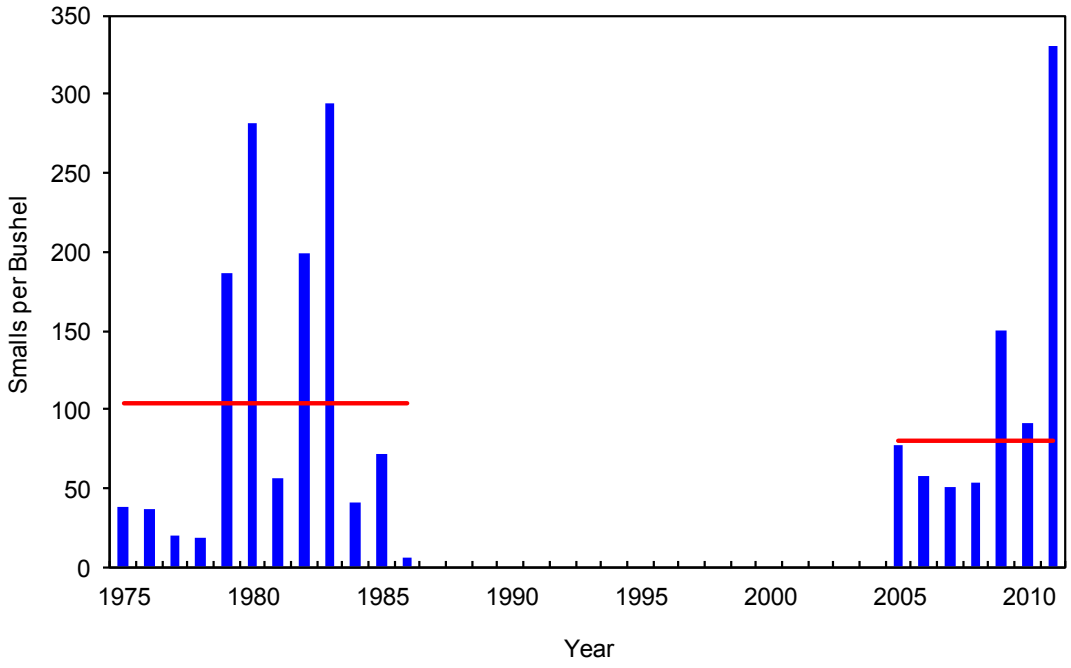

Figure 43. Mean number of small oysters per bushel derived from one bushel samples collected from Pleasonton's Rock, 1975-86 and 2005-2011.

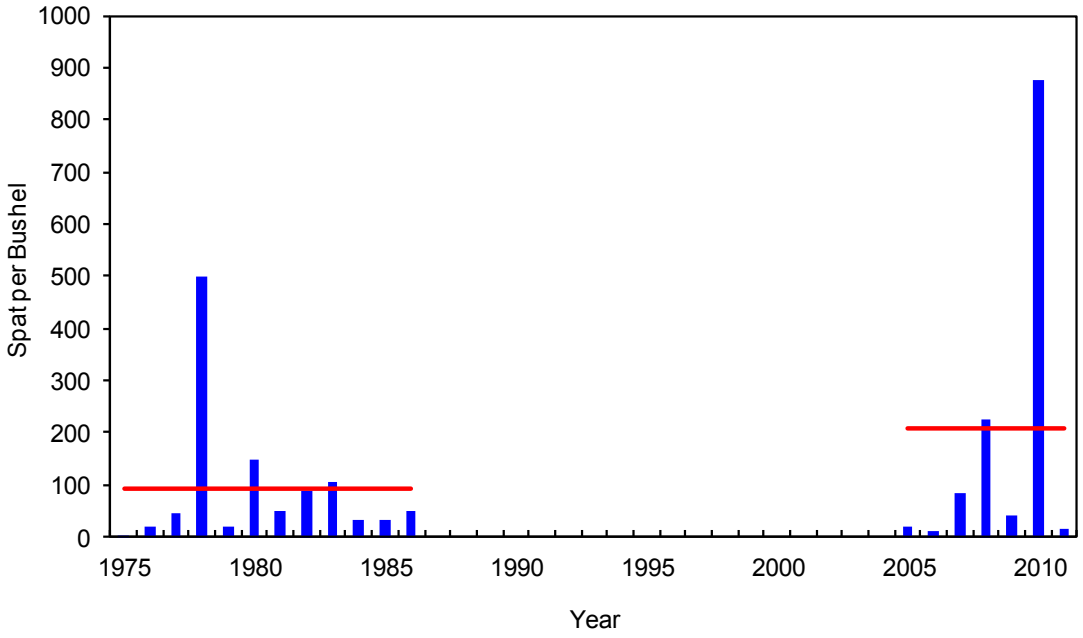

Figure 44. Mean number of spat per bushel derived from one bushel samples collected from Pleasonton's Rock, 1975-86 and 2005-2011.

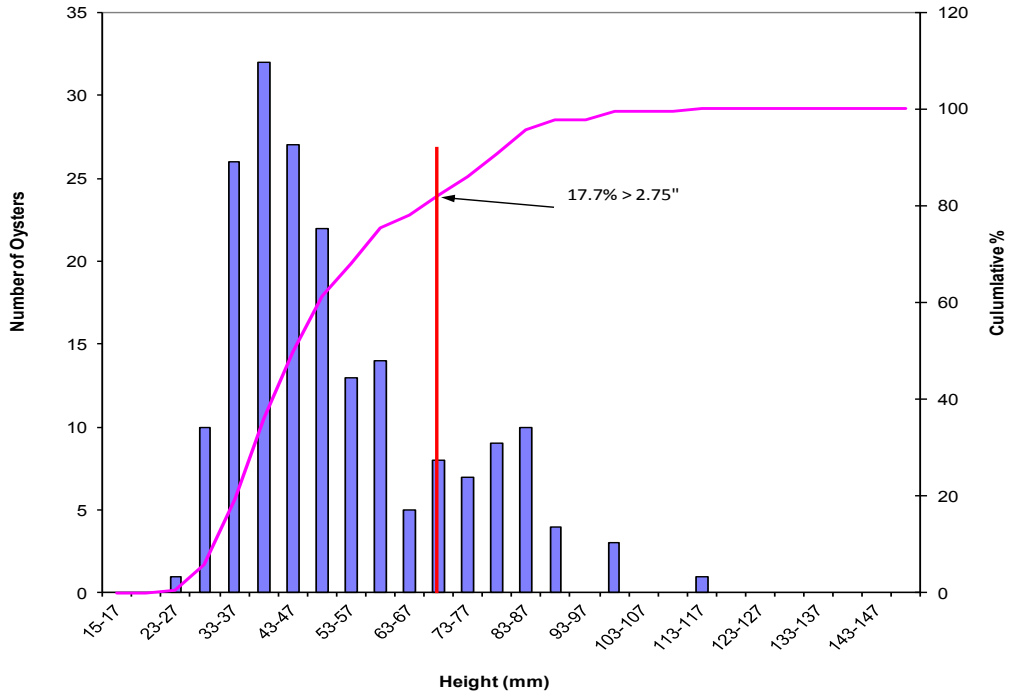

Figure 45. Height frequency of oysters collected from Pleasonton's Rock in 2011.

Black Can

The Black Can is one of the largest seed beds in terms of area in Delaware; however, it is not generally considered a major seed bed because of its location in relatively deep waters which tend to slow harvesting efficiency (Cole 1988). This area was routinely sampled as part of the survey until 2002 when it became increasing hard to obtain a viable sample. As part of remediation from the Athos I oil spill event in 2004 the State was awarded funding to restore oyster reef habitat. The allocated funding included a stipulation that this area could not be harvested for a period of five years. Based on bottom mapping data and several test drag conducted aboard the Division's research vessel, along with no harvest occurring on this area, it was determined that this site would be a suitable option for this project. In an effort to monitor the effects of this planting, the decision was made to again include this sample into the survey. A total of four samples were obtained from this bed. Two samples were taken from within the shell plant site (#2 & 3) and two were taken from outside the shell plant area (#1 & 4).

Abundance data for the area is listed in Table 12. The number of markets was above the historical average and was the highest level recorded when this area was sampled (Figure 45). The abundance of small oysters, 200.5 smalls per bushel, was the third highest level recorded during years in which this area was surveyed (Figure 46). Spat recruitment continues to be low, similar to that found during the last few years the areas was sampled (Figure 47). Based on the height frequency data collected, 43.4% of the population is over the 2 ¾" minimum size limit (Figure 48). This can be attributed to the lack of harvest that has occurred over this area, and barring any increases in natural mortality, these oysters should be able to provide sufficient brood stock for the planted area.

Table 12. Oyster stock density derived from one bushel samples collected from Black Can in 2011.

Station No.	No. Spat	Markets	Smalls	Boxes	% Shell
1	4	63	214	22	25
2	7	67	198	35	25
3	7	69	214	44	25
4	4	47	176	25	30
Avg.	5.5	61.5	200.5	31.5	26.3

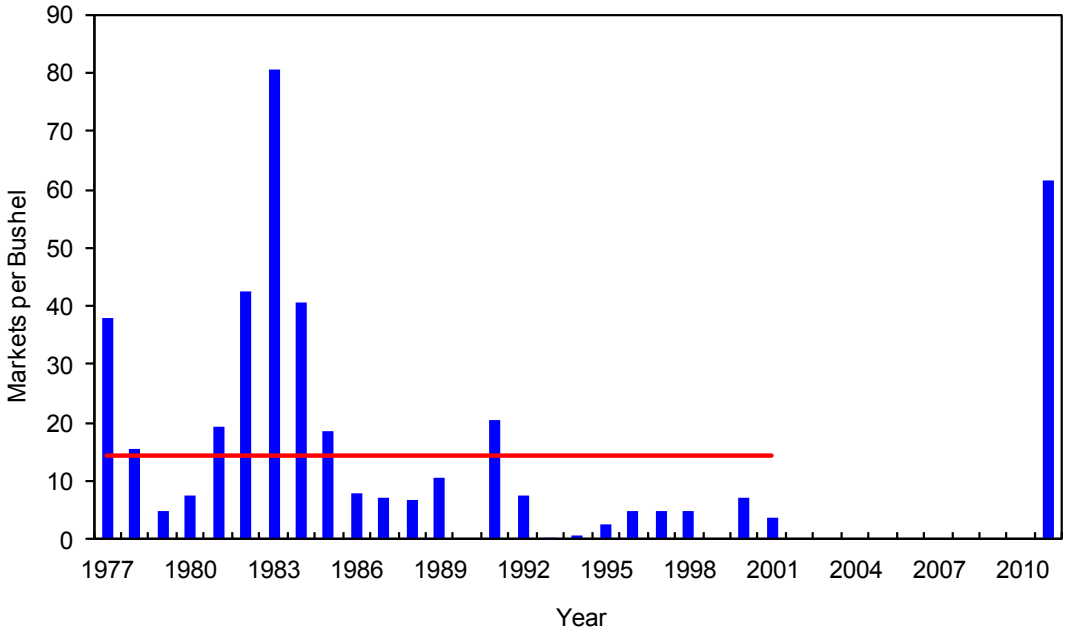

Figure 45. Mean number of markets per bushel derived from one bushel samples collected from Black Can, 1977-2002 and 2011.

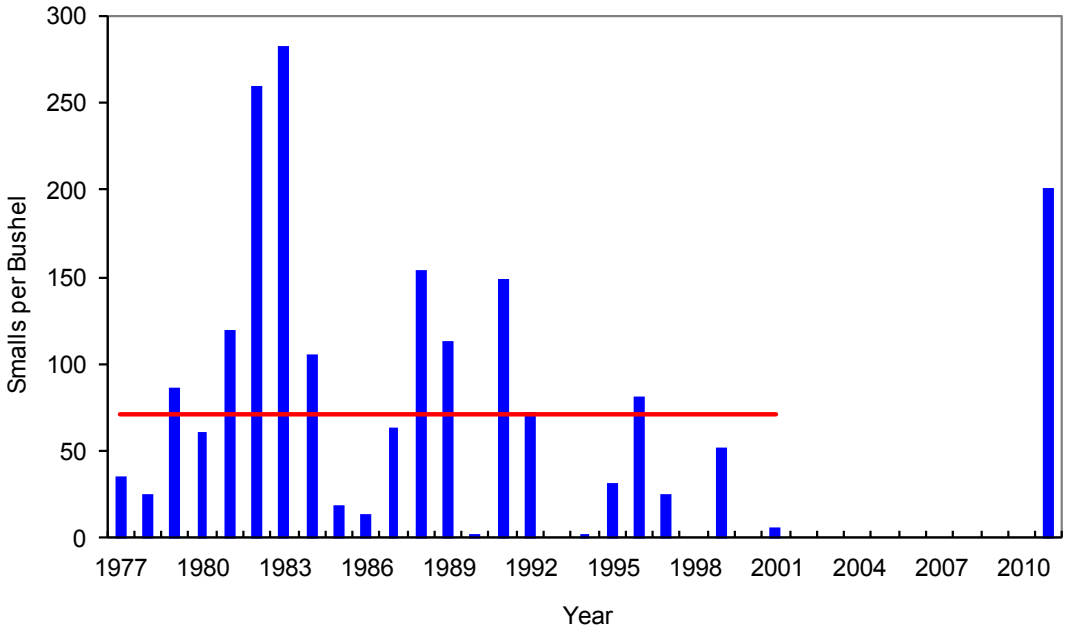

Figure 46. Mean number of smalls per bushel derived from one bushel samples collected from Black Can, 1977-2002 and 2011.

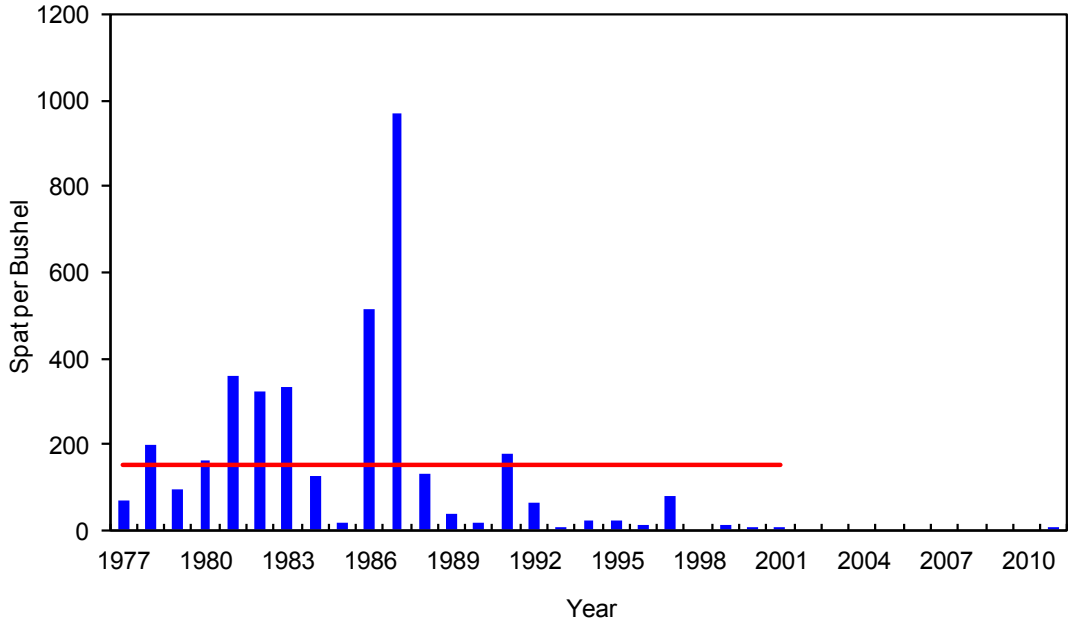

Figure 47. Mean number of spat per bushel derived from one bushel samples collected from Black Can, 1977-2002 and 2011.

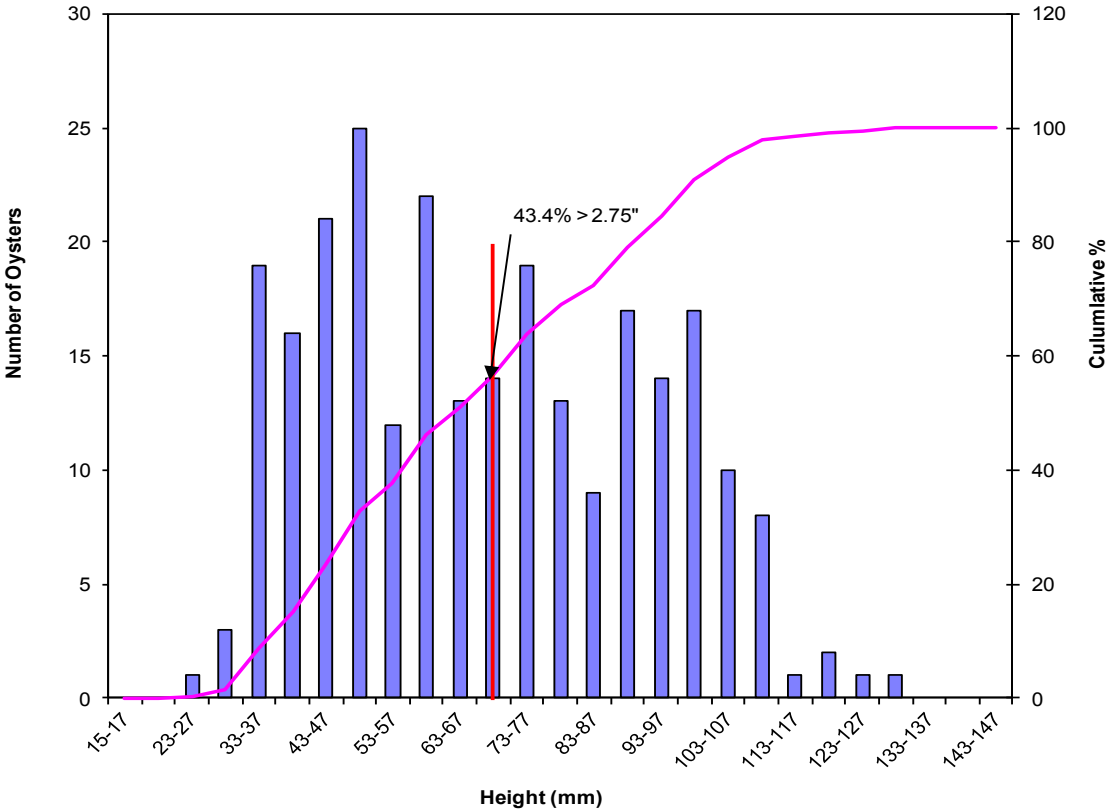

Figure 48. Height frequency of oysters collected from Black Can in 2011.

Literature Cited

Cole, Richard W. 1988. Natural Oyster Ground Survey – October 1988. Division of Fish and Wildlife, Dover, DE 19901.

Cole, Richard W., J.C. Tinsman and R.J. Seagraves. 1987. Technical Assistance to Commercial Fisheries. Division of Fish and Wildlife, Dover, DE, 19901.

Delaware Division of Fish and Wildlife (DDFW). 2012. Unpublished data. Division of Fish and Wildlife, Dover, DE 19901.

Greco, Michael J. 2005. Natural Oyster Ground Survey October, 2005. Division of Fish and Wildlife, Dover, DE 19901.

Newlin, Scott, M.J. Greco and W.H. Whitmore. 2007. Delaware Commercial Shellfish Harvest and Status of the Fisheries 2005-2006. Division of Fish and Wildlife, Dover, DE 19901.

Whitmore, W.H. and R.W. Cole. 2003. Delaware Commercial Shellfish Harvest and Status of the Fisheries 2001-2002. Division of Fish and Wildlife, Dover, DE 19901.

Whitmore, W.H. and M.J. Greco. 2005. Delaware Commercial Shellfish Harvest and Status of the Fisheries 2003-2004. Division of Fish and Wildlife, Dover, DE 19901.